

CRASH COURSE IN ENDODONTICS



DENTISCOPE

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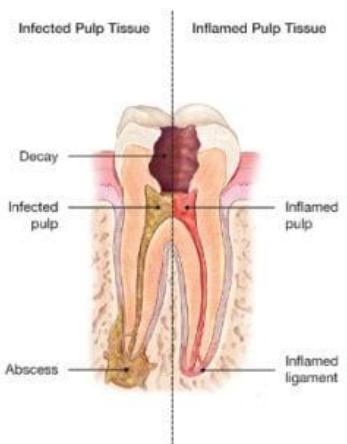
Pulp anatomy

1- Central region :

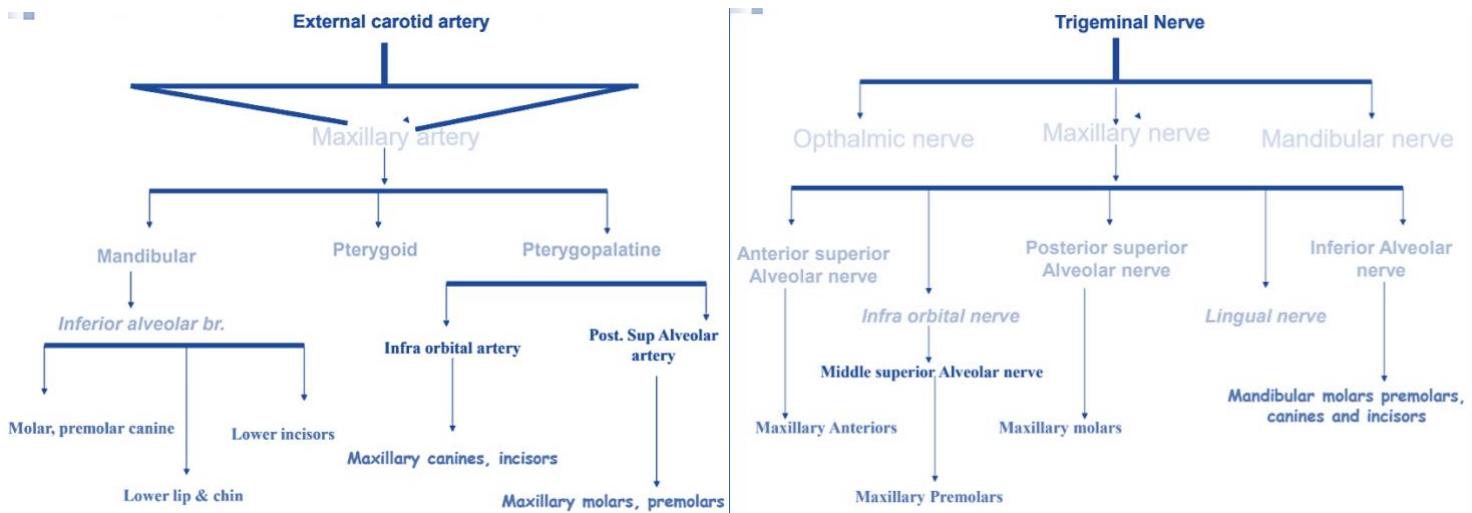
- Cells [odontoblasts + fibroblasts + undifferentiated mesenchymal cells + defense cells]
- Matrix [collagen type 1 and 2]
- ground substance [glycosamino glycans and glycoproteins]
- Bvs
- Nerves [subodontogenic plexus of rashkow + sensory afferent from trigeminal nerve]

2- Peripheral region:

- Odontoblastic layer
- Cell free layer – zone of weil
- Cell rich layer



Blood and nerve supply



- A - FIBERS = largest diameter - fast conducting → localized sharp pain
- C- FIBERS = smallest diameter – slow conducting → dull / throbbing pain

** when you use the EPT the A fibers get stimulated at first then as the intensity increases c-fibers get stimulated as well.

Pulp develops from the ectomesenchymal cells of the dental papilla, when the odontoblasts form dentine → the dental papilla changes into the pulp

Functions of the pulp:

- Formation of the dentine
- Maintain tooth fluid movement
- Sensation
- Proprioception
- Defense [by blood supply forming reparative and secondary dentine]

Pulp has minimal collateral supply which reduces its capacity for repair



Innervation of pulp is both simple and complex

- ◆ Simple – only free nerve endings and so lacks proprioception
- ◆ Complex – innervation of odontoblastic process which produces high level of sensitivity to thermal and chemical change

Causes of pulpal disease: [pathways bacteria can enter into the pulp]

- 1- **Caries** - Most common cause of pulpal disease is bacterial contamination from caries , percolation around restorations
- 2- **Trauma** [fractures, luxation, avulsion or chronic trauma like bruxism]
- 3- **Marginal leakage around restorations or during cavity prep**
- 4- **Periodontal pockets : through lateral canal and exposed DT**
- 5- **Anachoresis:** transportation of microbes through blood or lymph to a site of inflammation – does not occur in humans

Q: can radiation cause pulpal disease? Radiation affects the pulpal blood supply → pulpal necrosis , radiation also affects the salivary glands leading to hyposalivation → caries and pulpal disease

Q: how can caries cause pulpal inflammation? Carious lesions contain bacteria that get lesser as you get closer to the pulp but the pulp gets affected before the actual bacterial invasion by the noxious bacterial by- products. Once the pulp gets exposed to the bacteria → PMN infiltrate the pulp causing liquefactive necrosis that spreads throughout the pulp

****Pulpal infections are polymicrobial but anaerobes dominate**

Complications of untreated Pulpitis:

- **Upper teeth →** sinusitis → meningitis / brain abscess / orbital cellulitis and cavernous sinus thrombosis
- **Lower teeth →** ludwig's angina / parapharyngeal abscess / mediastinitis / pericarditis /emphysema



Endodontic microbiology

The main objective of endodontic treatment = prevention or elimination of apical periodontitis

- **Colonization** = establishment of microorganisms in a host
- **Infection** = when bacteria damage the host and produce signs and symptoms
- **Pathogenicity** = the ability of a microorganism to cause a disease / **virulence** = the degree of pathogenicity under certain circumstances

Q: What are the defense mechanisms of DT to prevent bacterial entry if cementum is exposed?

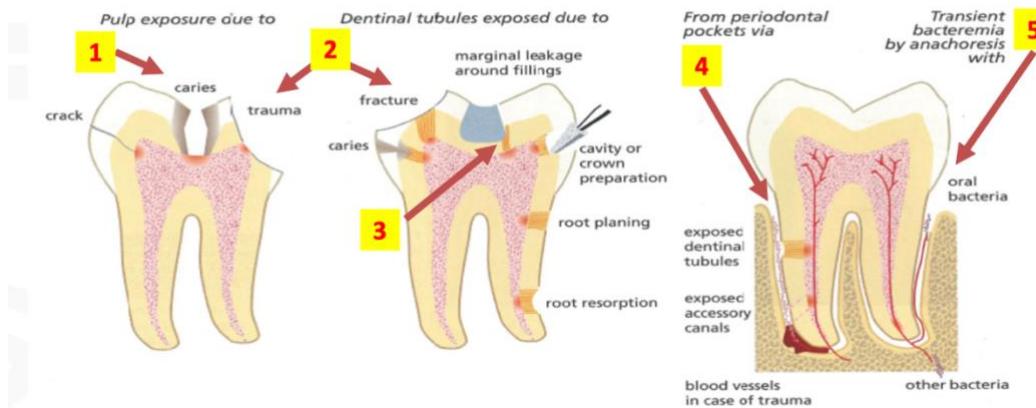
- 1- Outward flow of dentinal fluid
- 2- Presence of Odontoblastic processes
- 3- Presence of mineralized crystals and macromolecules like immunoglobins
 - A positive correlation exists between the **number of bacteria** in an infected root canal and the **size of periradicular radiolucencies**. [the more the bacteria the larger the RL]
 - No absolute correlation has been made between any **species of bacteria** and the **severity of endodontic infections**.
 - when a PA granuloma forms → it prevents the spread of infection to the surrounding tissue [a granuloma is the place where bacteria is killed]

Types of microorganisms present in bacterial infections:

- 1- Aerobes [**streptococci species**]
- 2- An aerobes [**enterococci, bacteroides , actinomyces**]
- 3- Fungi
- 4- Viruses – only in non – inflamed pulps of HIV / herpes pts
- 5- Spirochetes
- 6- Fusobacteria – associated with severe pain, swelling, flare ups

***e.faecalis* is mostly present in re infection cases – most resistant bacterial species .

Pathways to the pulp system





Diagnosis and treatment planning

- If you are in doubt postpone initiating treatment until symptoms localize
- Diagnosis must always include identification of the cause of the disease so it can be removed

1- History:

Chief complaint [when did it start, where is the pain, describe the pain [throbbing, sharp, dull etc], provoking and alleviating factors]

2- Clinical examination:

Soft tissue : [look for redness, swelling, sinus tracts etc]

Hard tissue : [examine tooth structure for caries, fracture , exposed dentine, integrity of current restorations if present, check restorability of the tooth]

Pulp sensibility tests - reproduce the pt's symptoms [you need at least 2 signs and symptoms to confirm a disease]

You always test the suspicious tooth LAST – do the test on an adjacent tooth + contralateral tooth and a tooth from the opposing arch.

1- Electrical pulp test [EPT]

- Gives no indication about vascular blood supply
- Make sure the field is dry and apply conductive paste [toothpaste or prophy paste] – apply EPT on the buccal surface of the tooth
- If the tooth is crowned → apply EPT on the margin of the crown
- EPT reaches a high # and the pt doesn't feel anything → -ve response

Causes of false positive of EPT	Causes of false negative of EPT
1- stimulation of nerve fibers in the periodontium or adjacent tooth 2- In multirooted teeth one canal might be non vital and the rest might be vital 3- Not objective test because it depends on pt's response 4- C-fibers might still be present in the pulp [more resistant to necrosis] 5- Cell bodies of neurons are located in ganglia outside the pulp	1- Inadequate contact with the stimulus. 2- Tooth calcification 3- Immature apical development 4- Traumatic injury 5- The test is subjective (Not objective) 6- Regressive neural changes in elderly patients 7- Patients who have taken analgesics

2- Heat testing [only used if the CC is pain on hot food / drink] – you can use:

- A. Heated Gutta percha / hot compound stick
- B. Dry rubber prophylaxis cup
- C. Hot water under rubber dam isolation [best for testing full coverage restorations]
- Apply a lubricant [petroleum gel] onto the tooth surface to prevent hot material from sticking - then place the heated GP or hot compound stick on the buccal surface

3- Cold testing [used when the CC is pain to cold] – you can use :

- A. Ice sticks [rarely used because cold water will leak into the gingiva and cause a false positive response]
- B. Ethyl chloride spray [best]



C. Carbon dioxide [dry ice sticks – extremely cold and can cause infraction lines in the enamel or pulpal damage]

** in case you need to repeat the cold test – wait for 5 mins

** in electrical / thermal pulp testing → A- delta fibers conduct the pain [sharp and well localized] – but in case of inflammation C – fibers are activated [not very well localized pain]

** electrical and thermal pulp tests are called **sensibility tests** because they only indicate nerve response **not blood supply** [we assume since there is nerve response that the pulp has viable blood supply and is vital]

4- Cavity test :

- Drilling the tooth without LA to ensure a negative response to cold/ hot test [specially when you can't notice a direct reason for necrosis]
- Used if all the other tests are inconclusive

Other tests that should be done during endo diagnosis:

1- **Percussion test:** when the inflammation spreads from the pulp to the PDL → the ability to localize the pain increases [because the PDL contains proprioceptive fibers]

- Tapping on incisal or occlusal surface by [digital pressure, end of a hand instrument , tooth sloth or a cotton swab] → TTP indicates periapical involvement
- Always do percussion test first with your finger then with the handle of an instrument

** tooth slooth allows the application of forces on individual cusps → very useful to detect fractured teeth



Ask the pt to bite down deeply and slowly then open very quickly- If the pain occurs on releasing → cracked tooth

To check for cracked tooth :

- Anterior tooth → transillumination
- Posterior tooth → bite test

other causes of +ve percussion test :

1- Traumatic occlusion / trauma injury

2- High restoration

3- Cracked tooth or vertical root fracture

4- Maxillary sinusitis

5- Periodontal abscess

2- **Palpation test:** when inflammation spreads beyond cortical bone → swelling can be detected by digital palpation

3- **Mobility:** done in buccolingual direction using index finger and the back of a hand instrument

Grade 1	Crown moves up to 1 mm in horizontal direction
Grade 2	Crown moves more than 1 mm in horizontal direction
Grade 3	Crown moves horizontally and vertically [easily displaced in the socket]

4- **Periodontal probing:** around the entire circumference of the tooth to detect any pockets and bone loss that might not be showing on xray

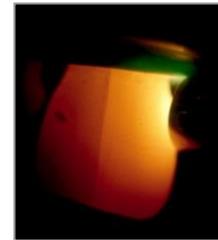
Causes of isolated deep pockets:



- 1- Periodontal disease
- 2- PA pathology draining through the periodontium
- 3- Developmental defect like Vertical grooves
- 4- Vertical root fracture
- 5- External root resorption

To detect cracks or fractures:

- **Fiber optic transillumination** can be used to detect cracks [the piece closer to the light will appear brighter]
- **dye staining** : dye is applied inside the access cavity and then re examined after one week.



Radiolucent lesion associated with a vital tooth is NOT FROM ENDODONTIC ORIGIN

PA radiolucency resulting from pulp necrosis has “ hanging drop appearance ” – beginning on the lateral surface of the root then extending apically. – this lesion does not change location when angles radiographs are taken.

Sinus tract tracing is done using GP size 35



Pulp diagnosis

PULP DIAGNOSIS	SYMPTOMS /TESTS	TREATMENT
NORMAL	SYMPTOMS: Asymptomatic PULP TESTS: Moderate response to electric pulp test [EPT] – response subsides upon removal of stimulus Sharp response to cold test but disappears upon removal of stimulus RADIOGRAPHS: Intact lamina dura , no resorption, no calcification or pulp abnormality SYMPTOMS: <ul style="list-style-type: none"> • Sharp pain that stops upon the removal of stimulus - Stimulus might be [hot, cold, sweet] • Pain can only be localized with cold stimulus History: recent dental tx, cervical erosion / abrasion PULP TESTS: EPT and Heat test = normal Cold test = exaggerated response that diminishes with the removal of stimulus Percussion = no pain RADIOGRAPHS: Caries or a restoration without an underlying base. Normal PA and PDL width	No treatment needed
REVERSIBLE PULPITIS	SYMPTOMS: History: recent dental tx, cervical erosion / abrasion PULP TESTS: EPT and Heat test = normal Cold test = exaggerated response that diminishes with the removal of stimulus Percussion = no pain RADIOGRAPHS: Caries or a restoration without an underlying base. Normal PA and PDL width	Remove caries , Adjust occlusion Apply appropriate base under the restoration



IRREVERSIBLE PULPITIS	<p>SYMPTOMS:</p> <ul style="list-style-type: none"> • Spontaneous intense pain – pain does not subside upon removal of stimulus ** • Pain at night ** • Pain localization with hot stimulus • Referred pain is seen <p>History: deep caries , trauma , large restoration</p> <p>PULP TESTS:</p> <p>EPT = elevated</p> <p>Heat test = acute pain</p> <p>Cold test = exaggerated response that lingers for around 30 sec (even after removal of the stimulus)</p> <p>Percussion= if PDL is involved → TTP</p> <p>RADIOGRAPHS:</p> <p>Caries, defective restoration, might have PDL widening</p>	Pulpotomy or pulpectomy
NECROTIC PULP	<p>Symptoms:</p> <p>Dry necrosis [no tissue element in the pulp space]</p> <p>Liquefactive necrosis [pulp tissue but without vascular element] – more likely to cause symptoms and less likely to cause PA pathosis</p> <p>Pulp tests:</p> <p>EPT / cold test / heat test = no response **</p> <p>Radiograph:</p> <p>Large caries, large restoration , PDL widening an PA radiolucency might be present [in this case tooth might be TTP]</p>	RCT

Peri apical diagnosis

PERI APICAL DIAGNOSIS	SYMPTOMS / TESTS	MANAGEMENT
APICAL PERIODONTITIS	<p>A. Symptomatic : [acute]</p> <p>TTP and pain on chewing**</p> <p>PDL within normal limits – can occur around vital and non-vital teeth</p> <p>Causes:</p> <ol style="list-style-type: none"> 1- Mechanical or chemical irritation from endo treatment 2- Hyper occlusion [vital pulp] 3- Inflammatory mediators from inflamed pulp 4- Microbial toxins from necrotic pulp <p>B. Asymptomatic: [chronic]</p> <p>Only with non vital teeth – no pain**</p> <p>Radiograph : wide PDL or a radiolucency</p> <p>Asymptomatic apical periodontitis has 2 histological variants :</p> <p>1- Peri apical granuloma:</p> <p>Chronically inflamed granulation tissue at the apex of the tooth</p> <p>Symptoms:</p>	<p>Symptomatic:</p> <p>Remove the cause</p> <p>Vital tooth → might need occlusal adjustment</p> <p>Non vital tooth → RCT</p> <p>Asymptomatic:</p> <p>RCT</p>



- 1- Asymptomatic [discovered on routine radiographs]
- 2- No TTP/ No mobility
- 3- No response to EPT / thermal test

Radiograph :

- 1- Widening of the PDL near the apex
- 2- Well circumscribed or poorly defined lesion
Some root resorption

Management :

Restorable tooth → RCT [to eliminate microorganisms in PA region]

Non restorable tooth → extraction + curettage

2- Radicular cyst :

Extension of the inflammation from the pulp to the PDL

Symptoms:

- 1- Asymptomatic [discovered on routine radiographs]
- 2- Involved tooth might be non vital or has a failed RCT

Radiograph :

Well defined radiolucency surrounded by a narrow radio opaque margin

Management:

- 1- RCT
- 2- Extraction
- 3- Marsupialization [for large cysts]
- 4- Apicectomy
- 5- Enucleation



** extension of inflammation from pulp to PA region can lead to granuloma formation → proliferation of epithelium → cavity filled with fluid and lined by stratified squamous epithelium → a cyst [the only way to know if the PA radiolucency is granuloma or cyst is by histological section]
** the epithelium in radicular cysts comes from epithelial cell rest of malassez

You always do RCT first if it heals → it was a granuloma if not then it is a cyst → surgical removal is indicated

Localized collection of pus in the alveolar bone at the apex of the tooth – caused by bacterial invasion into the periapical tissue following pulp necrosis

Symptoms:

- 1- Rapid onset spontaneous pain
- 2- pain to percussion and palpation**
- 3- fluctuant swelling **
- 4- systemic manifestations **

Diagnosis :

- 1- Clinical examination [TTP]
- 2- Pulp tests → **Pulp is necrotic**
** phoenix abscess =acute exacerbation of a chronic lesion

**1. Drainage by:**

- A. RCT
- B. Incision and drainage
- C. If non restorable tooth or for financial reasons / pt pref → extraction

2. Relieve the tooth out of occlusion
3. NSAIDs to control pain

** if there are systemic complications → fever , lymphadenopathy, cellulitis → give ABX

ACUTE APICAL ABSCESS

Might show slightly thickened PDL

chronic apical abscess:

- **Asymptomatic**
- **necrotic pulp**
- formation of a **sinus tract** [tracing of sinus tracts is done using size 35 GP]

sinus tract can drain to [facial skin, gingival sulcus , oral mucosa]

Tx of chronic abscess = RCT



CONDENSING OSTEITIS <p>A type of chronic apical periodontitis to a long standing irritant [tooth can be vital or non- vital] Asymptomatic Radiograph shows increased PA radio opacity</p>	
--	--

- Most diagnostic symptom of symptomatic **apical periodontitis** = pain on chewing / TTP
- Most diagnostic symptom of **radicular cyst** = well defined radiolucency at the apex
- Most diagnostic symptom of **acute apical abscess** = swelling
- Most diagnostic symptom of **chronic abscess** = sinus tract

Acute apical abscess is distinguished from lateral periodontal abscess by pulp vitality test. [apical

Acute apical abscess	Periodontal abscess
Pulsating, pounding continuous pain Easy to localize Continuous pain at night Tooth is mobile EPT/ COLD/ HEAT TEST = no response Swelling is present Radiograph = caries or defective restoration TX= drainage + ABX [if needed] + analgesics abscess → pulp is non vital]	Dull pain Localized by probing No pain at night Tooth is not mobile EPT/ COLD/ HEAT TEST = normal Occasional swelling Radiograph = foreign body / vertical bone loss TX = remove foreign body + SRP

Management of abscess:

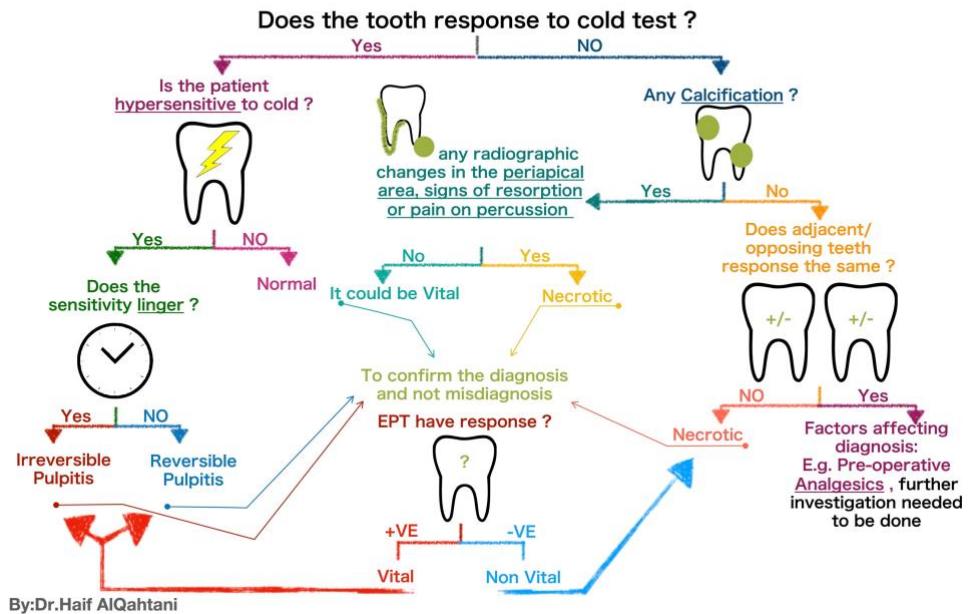
- 1- Identify and remove the cause
 - 2- RCT or if large do incision and drainage [I&D]
 - 3- In case of fever, malaise, trismus, progressive swelling → ABX
- Amoxycillin 500mg (child 10mg/kg up to 500mg) orally every 8 hours for 5 days
 - If hypersensitive to penicillin then → Clindamycin 300mg (child 7.5mg/kg up to 300mg) every 8 hours for 5 days
 - Unresponsive infections : Amoxycillin+ clavulanate 875 +125mg (child 22.5 + 3.2mg/kg up to 875+125mg) orally every 12 hours 5 days

In case of deep infections like ludwig's angina → air way is compromised the pt must be referred to a hospital to maintain airway and provide drainage



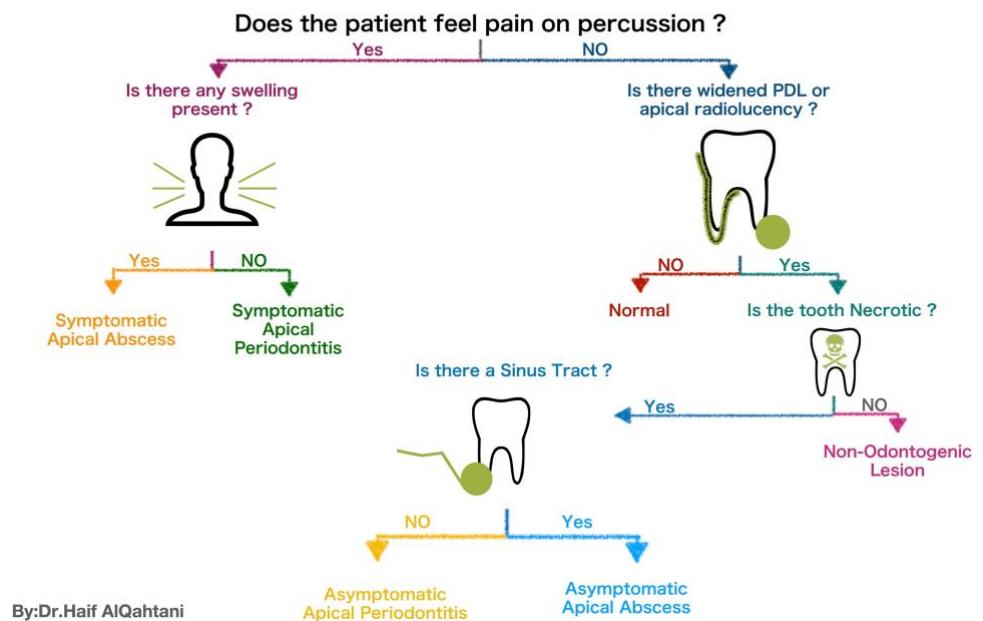
Decision tree for Pulpal Diagnosis

Decision tree for Pulpal Diagnosis



Decision tree for Periapical Diagnosis

Decision tree for Periapical Diagnosis



References:

-A clinical classification of the status of the pulp and the root canal system. PV Abbott,C Yu.

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E

-Cohen's Pathways of the Pulp - 11th



Pulp therapies

Q: what decides what type of pulpal protection is needed ? the remaining dentine thickness [RDT]

Cavity sealers: [cavity varnish / bonding agents]

- seal the DT to protect the pulp from chemical / bacterial irritation
- Usually used under amalgam
- Not used under composite / GIC [interferes with adhesion & polymerization]

Cavity Liners : few microns →

physical barrier against bacteria + some therapeutic effect like Fluoride release and antibacterial properties [CaOH₂ &GIC]

Cavity bases : few mm thick →

thermal and mechanical protection + replace missing dentine or block out undercuts. [Zinc phosphate , zinc polycarboxylate , GIC]

Pulp capping: procedures done when there is a near exposure or an actual pulp exposure - to maintain pulp vitality and limit the need for further endodontic treatments.

*pulp capping is **contraindicated** if the tooth will have extensive restoration , pathological exposure*

Mechanical exposure (accidental) occurs during the cleaning of the affected dentine. In cases of **carious (pathological) exposure**, the bacteria has already reached the pulp.

Restoration	Shallow cavity	Moderately deep cavity	Deep cavity
Amalgam	Varnish/DBA	Base	Ca Hydroxide liner,base
Composite resin	DBA	DBA	Ca hydroxide liner,GIC base
GIC	-	-	Ca hydroxide liner
Cast gold inlay and onlay	Luting cement	Base and luting cement	Ca hydroxide liner ,base and luting cement
Ceramic inlays and onlays	DBA and resin cement	DBA and resin cement	Ca hydroxide liner,GIC base,DBA and resin cement

Requirements of pulp capping :

- 1- Asymptomatic tooth
- 2- Hemorrhage can be easily controlled
- 3- Pulp is not inflamed or has signs of reversible pulpitis
- 4- No PA pathology [no radiolucency or TTP]



Indirect pulp capping	Direct pulp capping
<p>Done to avoid accidental pulp exposure in deep cavities</p> <p>You can use :</p> <ul style="list-style-type: none">- Ledermix Cement- Calcium hydroxide [Lfie, Dycal]- Zinc oxide-eugenol (ZOE) – reduce inflammation + pain- Glass-ionomer cement (GIC)	<p>In case of accidental pulp exposure</p> <ul style="list-style-type: none">- Pinpoint exposure less than 0.5 cm- Hemorrhage must be easily controlled- Minimal contamination [done under rubber dam] <p>You can use :</p> <ul style="list-style-type: none">- Ledermix Cement- Calcium hydroxide [Lfie, Dycal] <p>Both are susceptible to dissolution and must be covered by base [GIC]</p>

** Ca(OH)₂ is the gold standard for pulp capping but it has poor bonding to dentine , high material resorption and mechanical instability

** biociment = similar action compared to calcium hydroxide but without the drawbacks

Biociment can be used for: direct / indirect pulp capping – pulpotomy – tx of external and internal root resorption – apexification

Pulpotomy :

- Differs from direct pulp capping in that **a portion of remaining coronal pulp is removed before application of medicament. [radicular pulp is not removed]**
- **Usually better than pulp capping for primary teeth.**
- Most often used following **trauma.**

Pulpectomy : RCT [coronal and radicular pulp is removed]



Endodontic radiography

Radiographs are needed in endo for:

1- Diagnosis [pre operative radiograph]

- Identify any PA pathology
- Identify pulpal anatomy + number and curvature of the roots and canals
- 2- Working radiographs**
- Working length estimation , master cone confirmation , obturation confirmation
- 3- Post op radiograph of the RCT or after trauma [monitor for healing or development of any PA pathology]**

Radiographic techniques:

1- Angle bisecting technique:

2- Parallel technique :

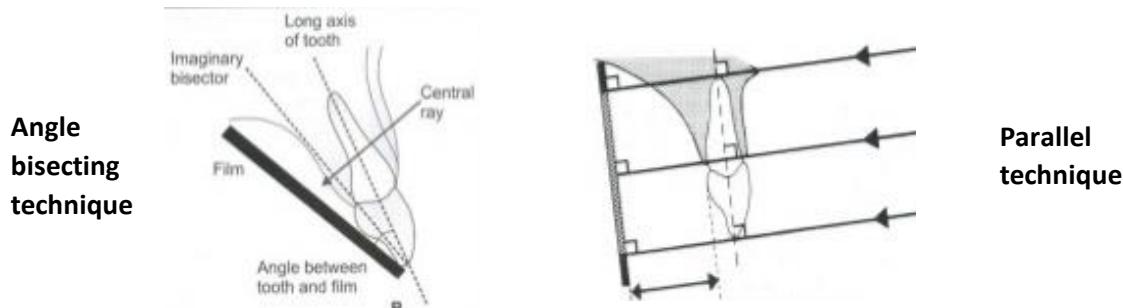
More accurate**

Causes **10% magnification** [magnification can be minimized by rectangular collimation and long cones]

Ex: if a tooth is 21 mm long it will appear 23 mm on a parallel radiograph [10% of 21 mm is 2.1mm]

3- Modified parallel technique :

To overcome the 10% magnification caused by the parallel technique → increase vertical angulation by 15 ° [to shorten the image slightly]



Positioning devices:

1- Film holders [Rinn XCP]

- A. most accurate
- B. easy to use – no hands needed
- C. positions the beam correctly and holds the film
- D. no film distortion or bending
- E. reproducible image over time



2- Styrofoam biteblock



3- hemostat with a bite block

** pt's finger causes the most bending of the film → least accurate

**Film sizes:**

Size 1	Narrow arches and anterior teeth
Size 2	Standard size for PA
Size 4	Occlusal views

**** PA lesions are always smaller on radiographs**

- infection will be present for at least 3-4 months before a PA radiolucency develops
- Whenever there is a radiolucency = there is an inflammation , no radiolucency there might still be an inflammation and the radiolucency did not form yet

Tube shift techniques	
Vertical shift	Horizontal shift
Decreasing the angle → elongate the image [no diagnostic or practical value] Increasing the angle by 15° [modified parallel technique] → more apical detail	Mesial and distal = separate objects that are superimposed over each other If you are suspecting an extra canal / perforation/ looking for the other root: U & L Central incisors → mesial shift U & L Lateral incisors and canines → distal shift U & L premolars → mesial shift Lower molars → mesial shift Upper molars → Mesial shift for DB root Distal shift for MB root



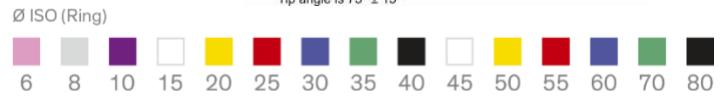
Endodontic instruments

FDI classification

Group I	Hand use only: K files, H files, reamers, broaches
Group II	Latch type engine driven [like group I but attached to a hand piece]
Group III	Latch type engine driven drills and reamers [peso reamer, Gates Glidden]
Group IV	RC points [Gutta percha, silver points, paper points]

Hand instruments: [numbered from 10- 100]

- The number **represents the diameter of the instrument in [1/100 of a mm] at the tip**
- Working blade in any size is always 16 mm extending from D1 [the tip] to D2 [16 mm away from D1]
- Hand instruments have a constant increase in taper of **0.02 mm per mm of length** [every 1 mm away from the tip has a taper greater by 0.02mm → Diameter of D2 is greater than diameter of D1 by 0.32 mm]
- Tip angle = $75^\circ \pm 15^\circ$
- Available lengths = 21,25,28,31 mm
- Hand instruments are color coded
[Number represents the diameter of the tip in 1/100 of a mm]



Instruments for pulp removal

Broaches

has barbs – used to remove the pulp



Rasps

have smaller barbs compared to broaches



Instruments for cleaning and shaping the canals

Reamers

Used by:

- Insert – twist to $\frac{1}{4}$ or $\frac{1}{2}$ turn then withdraw
- Less flutes than a file – but same cutting efficiency [because more spaces between the flutes \rightarrow better debris removal]
- Remain self centered in the canal \rightarrow less chance of canal transportation

K file

Used by:

- Insert – apply pressure against canal wall – withdraw the file while maintaining pressure
- Stainless steel wire that is triangular or square in C.S that is twisted to form the file

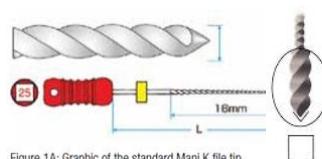


Figure 1A: Graphic of the standard Mani K file tip

H file

Used by:

- Insert – apply pressure against canal wall – withdraw the file while maintaining pressure
 - Flutes that look like successive triangles on top of each other [Christmas tree] – cut only when the file is withdrawn [because the edge faces the handle of the instrument]
- Aggressive cutter but lack flexibility and break easily

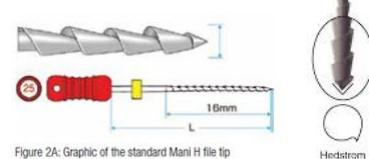


Figure 2A: Graphic of the standard Mani H file tip



Hedstrom

Lentilospiral: latch type attachment – used to carry the sealer into the canals

Peeso Reamer :

- Very stiff - Does not follow canal curvature and may cause canal perforation
- Used for :
 - A. Preparing space for a post

Gates Glidden :

- Flame shaped cutting point – latch type attachment to a slow speed hand piece – set of 6
- Used for :
 - A. Coronal flaring of the canal
 - B. Removal of GP
 - C. Preparing space for a post

Nickel titanium instruments: NiTi

- 1- Very good elasticity and resilience
 - 2- Shape memory
 - 3- Corrosion resistance
- Visual examination is not a reliable method to evaluate NiTi files because they can break without any signs of permanent deformation or unwinding – to reduce this risk **Bend the file at least 80 ° to see if the instrument breaks every time before you re- insert the file**



spreaders: used to pack GP [sizes from 15-45]

pluggers : diameter wider than spreaders – blunt end



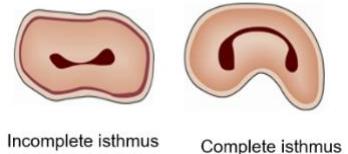


Endodontic procedure

Acess cavity

The objectives of an ideal access cavity: [how good your access cavity determines how good the RCT will be]

- 1- Gives straight line access to the apical foramen [unobstructed view of the canals]
The files should pass into the canal without touching any of the walls of the access cavity
- 2- Remove the entire roof of the pulp chamber so the pulp chamber can be debrided
- 3- Conserve as much tooth structure as possible
 - **Cemento dentinal junction:** where the cementum meets the dentine usually 0.1 mm away from apical foramen.
 - **Isthmus:** a narrow communication between 2 canals [can be complete or incomplete]- contains pulp tissue and acts as a harbor for bacteria → has to be cleaned



Incomplete isthmus Complete isthmus

Canal configurations

Type 1 Single canal from the chamber to the apex



Type 2 Two canals leaving the chamber but exiting as one canal



Type 3 Two canals leaving the chamber and exiting as two separate foramina



Type 4 one canal leaving the chamber and exiting as two separate foramina



Extra canals are mostly found in :

- Upper molars mostly have MB2
- Lower molars can have extra distal canal
- Mandibular incisors and premolars can have 2 canals

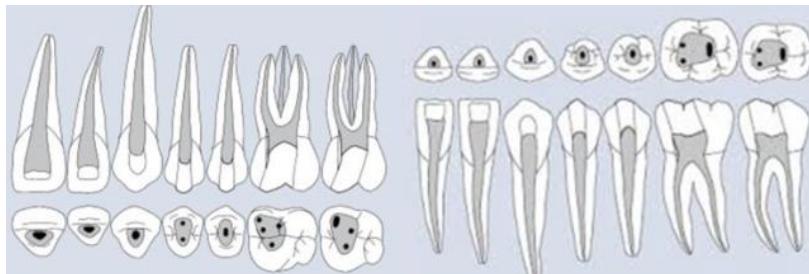
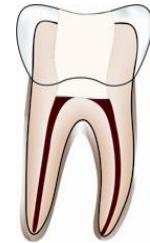
Dilaceration: extreme curvature of the root





ACCESS CAVITY DESIGN:

- 1- Before access – remove all defective restorations and caries -you can also check the depth of the preparation by aligning a bur next to a radiograph
- 2- Walls of the pulp chamber are flared to give a funnel-shape with larger diameter toward occlusal surface
- 3- Remove roof of pulp chamber completely so the pulp can be debrided completely – roof is removed in an upward cutting motion
- 4- Access cavity is either lingual or occlusal **never proximal or gingival**
- 5- If you need to gain access through a PFM restoration – use a round diamond bur to drill through the porcelain then switch to carbide to drill through the metal



To find MB2 canal in upper molars:

Mostly located between the MB and palatal canals

- Good lighting + dry field
- Look for a groove that extends from the MB orifice to the palatal surface.
- Use a file # 8 or #10 to search for the canal in this groove [many times the canal will be hidden by a shelf of dentine that has to be removed using low speed hand piece]

Special cases

- Extensive restorations:

Ideally the restoration should be removed completely before access cavity- if you prepare the access cavity through the restoration you will end up with :

- 1- Coronal leakage [the restoration loosens because of the vibration during drilling]
- 2- Poor access and visibility
- 3- Blockage of the canal because broken filling pieces may get stuck into the canal system
- 4- Misdirection of bur → perforation

- Tilted crowns:

Sometimes you might need to open pulp chamber without the rubber dam so that the bur can be placed at the right angulation.

Can lead to [failure to locate the canals, gouging, perforations, instrument separation]

- Calcified canals:

Use special tips for ultrasonic handpieces -They allow precise removal of the dentin from the pulp floor – should be done under magnification and illumination

Chelating agents also help in negotiating calcified canals

- Sclerosed canals :

Dyes can be used to located the canal

Ultrasonic tips can be used

Long shank low speed burs can be also used



Working length estimation

Q: why do you need to find the working length ? because it is the length at which canal preparation and obturation will be done.

Working length [WL] = the distance from the incisal edge or the cusp tip to 0.5 – 1mm **short** of the radiographical apex

The apical end of the root canal [cemento dentinal junction] is 0.5 -1 mm SHORT from the radiographical apex but sometimes the foramen is located laterally → more than 1 mm away from radiographical apex.

Reference point : site on the tooth from which measurements are made [usually the tip of the cusp or the highest point of the incisal edge] – **must be easily visualized during prep and stable** [does not change between appointments]

Q: How can you determine the working length?

- A> From pre op radiograph
- B> Using electronic devices [apex locator]
- C> Tactile sensation
- D> Bleeding on paper point [in case of open apex]

WL should be measured after gaining straight line access to the canals – *pre op WL estimation and actual WL might be different because much of the coronal deflection will be eliminated [mostly length will change in the mesial canals of molars]*

Procedure:

- 1- Estimate the WL from the pre op radiograph – you should also know the avg length for each tooth
- 2- Get a straight line access and place a file to the estimated length with the rubber stopper on the ref point
- 3- Take radio graph to verify if the length is correct or needed adjustment
** if file is more than 2 mm away from desired position → adjust and take another radiograph

Initial size / initial file : the largest file that can go to the full WL [should have slight resistance at the apical 3rd]

Apexlocator: electronic device that has a probe placed on the pt's lip and a clip that touches the shaft of a file inserted in the canal. Once the file is closer to the apex the resistance changes and this is displayed on the monitor. – **to confirm if your reading is accurate you can check the reading with different file sizes** – confirm the length by taking a radiograph.



BEST WL ESTIMATION PROTOCL = APEXLOCATOR CONFIRMED BY RADIOPHOTOGRAPH

Indications of using an Apexlocator:

- 1- Pregnant patients to reduce radiation
- 2- Children who can't tolerate taking radiographs
- 3- Disabled or heavily sedated pts



- 4- Pt's who can't tolerate radiograph because of gag reflex
- 5- Apex is obstructed by [tori, impacted tooth , shallow palatal vault , zygomatic arch , overlapping roots, excessive bone density]

Biomechanical preparation

Objectives of biomechanical preparation:

- 1- Obtain a continuous tapered conical form that mimics that natural shape of the canal
 - 2- Remove all necrotic tissue, pulp, bacterial toxins from the root canal space
 - 3- Provide enough space inside the canals for irrigation solutions and intracanal medications
- **Outline form :** the RC prep should be wider coronally than the middle and apical parts
 - **Retention form :** provided by the master cone tug back apically
 - **Resistance form :** provided by keeping the apical constriction as narrow as possible – to prevent overfilling
 - **Extension for prevention :** to locate any additional canals and remove all pulp debris

Instrumentation Motions:

- 1- **Filing** = push and pull
- 2- **Reaming** = push rotate pull
- 3- **Watch winding** = file rotated 2- 3 quarter turns clockwise then anticlockwise then retracted [most useful for initial canal negotiation]
- 4- **Balanced force** = with **flex O and Flex R files** – insert with quarter turn clockwise + apical pressure and **cutting** with counterclockwise rotation with apical pressure

Instrumentation techniques

Instrumentation techniques	
Apical – coronal	Coronal – apical
Step back Roane [balanced pressure]	Step down Double flared Crown down Hybrid

Step back technique [telescopic preparation] :

Phase I [apical preparation]:

Start with the initial file [the largest file that goes to the full WL] then enlarge 3 sizes to reach the master apical file [MAF] – in between each file **recapitulate** by inserting a small size file and removing the debris.

**All the 3 files reach the full working length



Phase II [preparation of the remaining of the canal]

After reaching the MAF enlarge the file size 3 times while reducing 1mm with each size to get the continuous taper of the canal.

Ex:

- WL = 20 mm initial file is 15
- you enlarge with 20 then 25 then 30 – 30 will be the MAF [all of those files will reach the full WL]
- Enlarge with file 35 [WL = 19] file 40 [WL = 18] file 45 [WL = 17]

<u>Advantages</u>	<u>Disadvantages</u>
Good apical stop	File tends to straighten in the canal
Good coronal flare	Loss of WL debris can block the canal

Crown down technique [pressure less technique] :

- Coronal flaring with gates glidden then incrementally remove dentine from coronal to apical area
- Start with large K - file [ex: size 60] with reaming action and no apical pressure , then use sequentially smaller files as you proceed apically
- Take radiograph when you reach estimated WL

https://www.youtube.com/watch?v=qfBYMA2_evQ

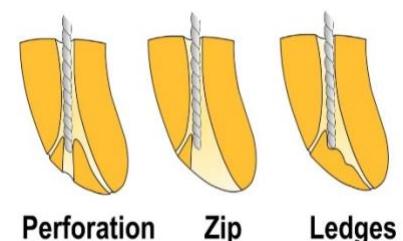
Balanced force technique : [Roane technique]

- Coronal and middle 3rd are shaped with Gates Glidden , apical part is shaped by hand files
- Position and pre load the instrument [engage the dentine] with clockwise rotation then cut and shape with counterclockwise rotation while maintaining apical pressure [otherwise the file will come out]
- The apex is prepared much larger than all the other techniques

<https://www.youtube.com/watch?v=AbxfYJFRB2A>

Q: what are the problems that can occur during instrumentation?

- 1- Loss of working length → due to canal blockage with debris if you don't recapitulate in between files
- 2- Ledge formation → not following the canal curvature or precuring the files
- 3- Zipping [widening the apex]
- 4- Stripping [lateral perforation]
- 5- Over instrumentation [instrumenting beyond the apex and injury to the PA region]
- 6- Over preparation [widening the canal prep too much]
- 7- File breakage



Niti files cause less canal transportation and ledge formation.



Irrigation

Importance of irrigation :

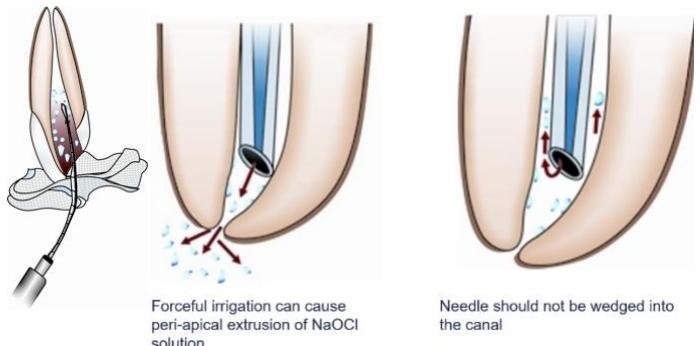
- 1- Flush out bacteria and debris that form from bio mechanical preparation out of the canals
- 2- Lubricates the canals during instrumentation and increase efficiency of files / instruments
- 3- Remove debris from lateral / accessory canals/ fins / deltas and other areas files can't reach and clean
- 4- Dissolves necrotic tissue / pulp remnants and remove smear layer
- 5- Use solutions that have antibacterial properties to improve sterilization of canals and overall success of the RCT

Ideal irrigant solution:

- 1- Should have broad spectrum antimicrobial properties / inactivate bacterial endotoxins
 - 2- Ability to dissolve necrotic tissue or debris
 - 3- Good lubricant
 - 4- Low surface tension to flow into inaccessible areas
 - 5- Dissolves the smear layer
- 5.25% NaOCl has better tissue dissolving capacity
 - **warming NaOCl syringes in a water bath at 60-70°C → increases its effectiveness**

Q: how can you check if the canals are clean or not yet?

Place a gauze near the access cavity and irrigate then check the gauze to see how clean the solution is and if there are any debris.





IRRIGATION SOLUTIONS	PROPERTIES
SODIUM HYPOCHLORITE [NaOCl] 0.5 % - 1 % = ANTIBACTERIAL PROPERTIES 5% = TISSUE DISSOLUTION	<ul style="list-style-type: none"> Oxidizing action Degrades organic matter [proteins and lipids] High PH = 12 Easily miscible with water and gets decomposed by light Pale greenish yellow liquid with strong odor of chlorine No difference between 0.5% and 5 % NaOCl in terms of anti bacterial activity Does not remove smear layer <p>3 main reactions:</p> <ul style="list-style-type: none"> - Soaping of lipids - Neutralization of amino acids - Chloramination <p>Preferred concentrations of NaOCl: For antibacterial effect → low concentration [0.5 – 1 %] For necrotic tissue dissolution → higher concentrations [5%]</p> <p>** pretreatment with Ca(OH)2 can enhance tissue dissolving capacity of NaOCl ** combination of 5 % NaOCl + EDTA → better anti bacterial properties + removal of Smear Layer</p>
CHLOROHEXIDINE [CHX] 2%	<ul style="list-style-type: none"> Alters the bacterial cell membrane - low concentrations it is bacteriostatic, at higher concentrations is bactericidal Excellent antimicrobial properties but no protein dissolving properties Does not remove smear layer High substantivity [antimicrobial action remains for a long time] Less effective compared to NaOCl Stains canals and teeth <p>** if you mix CHX with NaOCl → better antibacterial effect ** increases effectiveness of Ca(OH)₂ when combined as a dressing.</p>
EDTA	<ul style="list-style-type: none"> Little/ no bactericidal effect Used in conjunction with NaOCl effectively removes smear layer Used before dressing the canal and before obturation
MTAD	<ul style="list-style-type: none"> Doxycycline [ABX] + citric acid + Tween 80 Best bactericidal activity [more than NaOCl and EDTA] Removes smear layer + open DT and allow antimicrobial agents to penetrate the entire root canal system Doxycycline has high binding affinity to dentine providing long antibacterial effect [main difference compared to EDTA] Effectiveness of MTAD increases when low concentrations of NaOCl are used as an irrigant followed by a final rinse of MTAD

Best protocol is using 1.3% NaOCl as an irrigant followed by final rinse with MTAD



Ultrasonic irrigation :

- more effective bacterial elimination by causing acoustic streaming + scrubbing effect
- Files must be small and loose to achieve optimum cleaning with ultrasonic vibration

Advantages	Disadvantages
1- Effective removal of smear layer 2- Effective removal of debris	1- Unpredictable 2- Can lead to excessive cutting of the canal wall

Smear layer = a loosely adherent layer the forms on the canal walls after instrumentation consists of dentin debris, pulpal tissue and microorganisms – can penetrate slightly into the Dentine tubules.

Smear layer has to be removed because :

- 1- Harbors micro organisms and allows their proliferation
- 2- Can cause microlleakage
- 3- Interfere with the physical properties and the adaptation of the sealer

Proposed irrigation protocol:

- 1- EDTA gel and NaOCl irrigation during canal prep
- 2- Smear clear for 1 min
- 3- Intracanal medication
- 4- CHX irrigation then smear clear before obturation

Intracanal medication

Q: why do we place intracanal medications? Mechanical instrumentation + irrigation alone removes only 70% of bacteria in the canals . Intra canal medications are placed in between appointment to:

- 1- Destroy bacteria that remains inside DT, lateral canals , ramifications and fins. And prevent their growth
- 2- Prevent bacterial contamination in between appointments
- 3- Help in managing weeping canals
- 4- Control inflammatory resorptions

Ideal intracanal medication:

1. Effective germicide and fungicide with **prolonged antimicrobial effect**
2. Remain active in the presence of blood, pus etc
3. Should be non irritating to the tissue and does not interfere with healing of PA region
4. Should have low surface tension and remain stable in solution
5. Reduce pain and induce healing



INTRACANAL MEDICATIONS

PHENOLIC COMPOUNDS ESSENTIAL OIL [EUGENOL]	<p>Ex: CMCP</p> <ul style="list-style-type: none"> Dressing of choice for infected teeth High level of toxicity Antimicrobial activity might not last very long Palliative effect – because it inhibits prostaglandins synthesis and nerve activity High doses are toxic and irritating to PA tissue
ALDEHYDES	<ul style="list-style-type: none"> Formaldehyde / glutaraldehyde Potent disinfectants Cytotoxic & carcinogenic Formacresol = formaldehyde is the main ingredient – most widely used medication for pulpotomy ** paraformaldehyde is a component of endomethasone obturating material – it decomposes slowly to give out formacresol
HALOGENS QUATERNARY AMMONIUM COMPOUNDS	<p>Chlorine = active ingredient of NaOCl Iodide = potassium iodide</p> <p>Ex: Biocides = chemicals that can inactivate a variety of microorganisms</p> <ul style="list-style-type: none"> PBSC paste [ABX that contains Penicillin , Bacitracin, Streptomycin, Caprylate] – no longer used because it caused allergic rxn Ledermix ** [ABX + corticosteroid] = Tetracycline, demeclocycline HCl+ triamcinolone acetomide in a polyethylene glycol base
ABX + CORTICOSTEROIDS	<ul style="list-style-type: none"> Antiseptic action because of it's high PH = 12.5 – it has antibacterial effect as long as it's PH remains at high levels Ca(OH)2 can easily be buffered by dentine and lose it's antibacterial effect Effective against dead bacteria that might remain in the canal and can still cause an infection Used when you expect long delay between appointments because it is effective as long as it remains in the canals. But it can cause calcifications inside the canals – has to be changed every 3 weeks Inhibits root resorption and stimulates PA healing <i>E. faecalis</i> = fairly resistant to Ca(OH)₂
CALCIUM HYDROXIDE CA (OH)2	<p>**Most common bacteria associated with endo failure = <i>e.faecalis</i> [can survive at low PH and high temp and withstand starvation + forms biofilms inside canals]</p>

Weeping canals: a constant reddish or clear exudate associated with radiolucency . the tooth might be asymptomatic or TTP, next appointment exudate stops and then reappears again in the appointment after.

Management: dry the canal with paper points then place Ca(OH)2 → next appointment the canal is dry and ready to obturate

Q: how are intracanal medications applied?



- A. Intracanal medication on a cotton pellet is placed inside the pulp chamber and over it a sterile dry cotton pellet and sealed with temporary filling.
- B. Paste intracanal medications → inject with a long narrow tip inside the canal then use a lentilospiral to spread the medication inside the canal

Temporization

Good endo but poor coronal restoration will have higher failure than poor endo with good restoration.

Temporization material requirements:

- 1- Seal the access cavity against saliva and bacteria
- 2- Have acceptable esthetics and strength
- 3- Easy to apply and remove

Patient can still exist in a state of chronic inflammation without measurable symptoms

Complete healing occurs only in a small % of cases

Placing a cotton pellet over the canal orifice is controversial:

Advantages	Disadvantages
<ul style="list-style-type: none">- Allows you to remove the TF without the risk of removing unnecessary tooth structure or perforating the pulpal floor- Prevents blockage from the TF debris going inside the canal	<ul style="list-style-type: none">- Reduce the thickness of the temporary material- Act as a cushion under the temporary material → compromise the stability of the restoration- Increases risk of leakage into the canals- Might compromise the adaptation of temporary materials

- Cotton pellet should only be placed over the canal orifice and not the pulpal floor
- Temporary material should have adequate bulk , place it in small increments and properly condense it – finish the margins and adjust occlusion



Temporization of an access cavity done inside tooth structure

Zinc oxide/ calcium sulphate preparations [Cavit – coltosol]	<p>1- High coefficient of thermal expansion → expands and has excellent sealing ability</p> <p>2- Low compressive strength [needs sufficient bulk]</p> <p>3- Easy to place and remove</p> <p>** cavit G & cavit W = vary in their resin content and their hardness</p>	
Zinc oxide eugenol preparations	<p>Plain ZOE is less effective than cavit</p> <p>Kalzinol = ZOE reinforced with 2% polystyrene polymer to increase its compressive strength</p>	
	<p>IRM = ZOE reinforced with polymethyl methacrylate</p> <ul style="list-style-type: none"> - better compressive strength + abrasion resistance - Eugenol prevent bacteria colonization in case of leakage <p>** comes as capsules used with amalgamator</p>	
GIC	<p>1- Chemical adhesion to tooth structure → very good sealing ability [used when you need to temporize for a long time]</p> <p>2- Fluoride release → anti bacterial</p> <p>** difficult to distinguish GIC from tooth structure during removal</p> <p>** fuji VII – has pink color [easy to identify]</p>	
Composite resin [TERM – temporary endodontic restorative material]	<p>Single component light cured resin [UDMA]</p> <p>No antibacterial properties</p> <p>High hardness , compressive and tensile strength + good marginal seal</p>	

Temporization of an access cavity within a restoration

Restoration type	Temporization material you can use
Amalgam	Cavit or IRM Zn phosphate or Zn polycarboxylate should not be used [they provide poor seal]
Composite	ZOE or Cavit
Gold	Cavit or IRM
PFM crowns	Cavit or IRM

If you doubt the seal and the integrity of the primary restoration it is better to remove it entirely and replace it

If the final restoration is going to be resin:

- Don't use ZOE , eugenol will compromise resin polymerization [cavit and IRM can be used]
- Use total etch adhesive systems [the phosphoric acid will remove any remnants]



Temporization of a badly broken down tooth:

- 1- Composite / GIC
- 2- Provisional crown
- 3- Temp post + crown [only when custom post + core is needed]
 - A. If the tooth is indicated for fiber post → restore ASAP
 - B. If the tooth is indicated for custom post → place temp post + crown [for as short as possible because they have significant leakage]

Temporization for walking bleach:

After placing the bleaching agent, all cavity walls should be cleared of the material and access is temporised with [Polycarboxylate cement or ZnPO₄ or GIC or IRM or Cavit atleast 2mm thick]

The gas release inside the chamber may result in the loosening or displacement of the temporary restoration

Temporizing after apexification / root resorption treatment : composite or GIC [you can place cavit directly over the orifice to easily identify the access later and avoid unnecessary loss of tooth structure]

Obturation

Poor obturation = a major cause of endo failure - Poorly obturated teeth are mostly poorly prepared

- Dressing of Ca(OH)2 is required for at least a week for all necrotic teeth
- Single visit endodontics can be done if the tooth is vital

Q: why do we obturate the canal? If we leave the canal empty → bacteria and fluid will ingress from the PA region and grow inside the canal again → re infection [in an ideal environment]. That's why we need to create a fluid tight seal of the apical foramen, the oral cavity and the canal walls to prevent ingress of bacteria and tissue fluid.

We obturate to the apical constriction only → to encourage apical healing

Q: when can you obturate?

- 1- Pt is asymptomatic [no pain, swelling . TTP]
- 2- TF is intact and no communication between canals and oral cavity
- 3- No foul smell of the canal
- 4- Canal is dry with no exudate

Ideal obturation material :

- 1- Easy to introduce into the canal and easy to sterilize
- 2- Seal the canal 3 dimensionally and dimensionally stable
- 3- Impervious to moisture
- 4- Radio opaque
- 5- Biocompatible and non irritating to the PA



Obturation materials		
Gutta Percha [semi solid]	<ul style="list-style-type: none"> Basically dried plant extract – similar to natural rubber 3 phases: <ul style="list-style-type: none"> A. Alpha = runny, tacky, sticky B. Beta phase = solid, compactable and elongatable C. Gamma phase = unstable form <p>** expands when heated and shrinks when cooled Can show some tissue irritation because of the high content of ZnO Types:</p> <ol style="list-style-type: none"> 1- Solid core [standardized or non standardized] 2- Thermo mechanical compactable GP 3- Thermoplastized GP 4- Medicated GP 	
	Advantages: 1- Compactible 2- Dimensionally stable 3- Inert 4- Radiopaque	Disadvantages: 1- Lack of rigidity – bends easily and cannot be used in small canals 2- Easily displaced by pressure 3- Lacks adhesive properties
Silver points [solid]	Advantages: Rigid – can be used in narrow curved canals	Disadvantages: Not good sealing Corrosive products Not easy to remove
Pastes [ZOE, calcium hydroxide , resin]	Advantages: Easy to use Fills irregularities Acts as lubricant	Disadvantages: Some pastes are toxic Some pastes dissolves over time Poor seal

Q: how do you sterilize GP? immersed in 5.25% of NaOCl and then rinsed in H2O2 or alcohol.

Q: how do you dissolves GP? Chloroform or eucalyptus oil

Sealers

- 1- Fills the space between GP and the canal wall to provide 3D obturation
- 2- Fills accessory canals and small irregularities
- 3- Lubricant that aids in the seating of the GP

Types of sealers:

- 1- Zinc oxide
- 2- Calcium hydroxide
- 3- Glass ionomer
- 4- Resin

All sealers exhibit toxicity until they set, so extrusion should be limited as much as possible.

Sealer placement: lentilospiral OR with a clean file OR coating the master cone

AH plus sealer : Mix to thick, creamy consistency which breaks when spatula lifted 1.5 - 2.5 mm above the glass slab. Has long setting time so you can mix it early in the appointment



Obturation techniques:

- 1- Cold lateral condensation
- 2- Warm lateral condensation
- 3- Warm vertical condensation
- 4- Thermo plasticized GP
- 5- Single point obturation

Cold lateral condensation : Insert master cone [same size as master file] – insert spreader [spreader should reach full WL or 1-2 mm shorter] – use the spreader to displace the GP laterally and make space. Remove spreader and place accessory GP

If GP too short :

Recheck working length and check for debris that might be blocking the apex or file again and recheck the GP

If GP too long:

Cup off the tip of the GP or try a larger GP



Clinical endodontics

1- Medical history and CC [you need to know if the pain is odontogenic or non odontogenic]

** non odontogenic pain:

- A. Pain without a local cause [pt tells you this tooth is painful but the tooth is perfectly intact]
- B. Burning, continuous, non variable pain
- C. Pain persists over months or years
- D. Spontaneous multiple teeth are painful

In general there is no actual contraindication for RCT, however there is limitation in 2 cases :

A periapical lesion [source of infection] in :

- A. Pt on immune suppressants [specially kidney transplant patients]
- B. Pt going to have cardiac surgery [there is risk of infective endocarditis]

In a kidney trans plant pt if the tooth is vital → do RCT but if there is a PA lesion → extraction

2- Examination [soft and hard tissue] + clinical tests + radiographs

- if there was an endo perio lesion : if the primary cause is endo → better prognosis
- If the pt cannot identify which tooth hurts → give inferior alveolar nerve block if the pain disappears the offending tooth is in the lower arch, if not it is in the upper arch . or if two adjacent teeth have pain and you can't identify which one to access → give LA to one tooth → pain subsides → access this one if not you access the other tooth

Q: differential diagnosis of a well-defined PA radiolucency associated with a VITAL PULP?

- 1- Traumatic bone cyst
- 2- Developmental bony defect
- 3- Periapical cementoma
- 4- Early ossifying fibroma

Preoperative radiographs allow you to:

- 1- Identify any PA pathology
- 2- Identify pulpal anatomy + number and curvature of the roots and canals
- 3- If you have patent canals or calcified canals
- 4- If there is a sinus tract that is traced by a GP – a radiograph allows you to know the source of infection
- 5- Orientation of the tooth [to know how you need to orient your bur during access and avoid perforation]
- 6- Length of the root [helps you know if you need to adjust your needle during LA]

After taking the pre operative radiograph - estimate the distance between the occlusal surface and the pulp chamber [usually in molars if you are 7 mm deep that means your bur is in pulp chamber → start looking for the canals horizontally]



Anesthesia

General rule:

- Vital tooth / TTP / anxious pt → give LA
- non vital tooth → better not to give LA [you want the pt's feedback during instrumentation and WL to make sure you don't go beyond the apex]
 - a- maxilla → you don't need to anesthetize palatally
 - b- mandible → you don't need to anesthetize lingual or buccal nerves

if the pt still has pain after LA in the mesial root of a lower 1st molar → tooth might have extra innervation from superficial cervical plexus or mylohyoid nerve [in this case you need to anesthetize lingual nerve]

Q: how can you check the effectiveness of your LA? Insert a probe b/w the lateral incisor and the canine → no pain means your block is effective [this areas has innervation only from the IAN]

Q: why do u need to give LA in every session? Pulp has complex anatomy and there might be pulpal remnants that can cause pain during insertion of the spreader , irrigation or filing .

Caries removal + access cavity

Caries removal is done to:

- 1- remove the source of infection [if you place TF over caries there will be microleakage]
- 2- you will know if the tooth is restorable or no

caries removal is always done by a hand excavator not by hand piece. [you can widen the cavity with a bur then remove the caries with a hand excavator -done from periphery towards the center to decrease microbial contamination of the pulp]

You always perforate the pulp chamber above the widest canal [distal in the lower molars and palatal in the upper molars] because :

- 1- it is easier to feel the bur drop
- 2- it is the last canal to calcify
 - if you can't locate the canal in an anterior tooth → move the bur more palatally to avoid buccal perforation
 - If the pt still has pain you can give intrapulpal injection [before pulp extirpation] – if you give it after pulp extirpation it is useless.

If the tooth has a class 2 → build the wall and change it to class 1 so you can place the rubber dam better and the wall will help keep the irrigation inside the canals during instrumentation

Importance of de roofing in access cavity :

- 1- Remove all pulp tissue [if pulp tissue remains it can cause tooth discoloration later on or infection]



- 2- Obtain straight line access – otherwise the files will be bent and they can break inside the canals or cause apical transportation or ledge formation.
- 3- Make sure you don't miss any canals

**** finding the canals does not mean you have completed de roofing.**

Errors in access cavity:

- 1- **Gouging**: you miss the direction of the pulp chamber [but still a perforation did not happen]
 - Gouging of the labial wall → due to failure to recognize the lingual inclination of the tooth
 - Gouging of the distal wall → due to failure to recognize the mesial inclination of the tooth
- 2- **Perforation**
 - 3- **No straight line access [insufficient de roofing]**
 - 4- **Missed canals**



Dentine map: darker dentine that connects the orifices of the root canals.

After access cavity → identify number of canals and irrigate

RCT should start and end with irrigation - You should irrigate before starting instrumentation

Widen the orifice with gates glidden [this is needed in manual instrumentation and lateral condensation technique] – no need to widen the orifice if you are using rotary

Opening the orifice with GG allows better obturation and sealing

Working length estimation

- Estimated WL → apex locator
- Actual working length → apex locator reading + PA radiograph

Use different files for different canals [K and H files] – **repeat the radiograph if the file is more than 2 mm away from the apex**

Q: how can you avoid false readings of the apex locator?

- 1- Irrigate the canals then use high volume suction [the canal should not be very wet or very dry]
- 2- Select the suitable file size [usually size 10 or 15]
- 3- Push the file until the monitor shows it passed the red line and then slightly pull it back by 0.5 -1 mm

Bio mechanical preparation

Oval canals [mostly in lower premolars and upper second PM] → treat as if it is 2 canals to ensure sufficient cleaning

Q: how can you know that a canal is curved ? insert a size 10 file [very flexible] and place the notch on the rubber stopper towards the buccal surface – you can know the location of the curve in relation to the buccal surface - If the canals are curved → pre bend the files [starting from size 20]



Initial file = the largest file that can reach the full working length

Instrumentation:

Step 1 : Standardized technique : you treat the entire canal as one piece [prep is done all over the length of the canal] – motions : filling , watch winding, $\frac{1}{4}$ turn and pull

You enlarge 3 size after the initial file [all will go to the full working length] – the file that is 3 size bigger than your initial and goes to full WL [master file]

EX: If your initial file is 20 you need to enlarge 25,30,35 . but when you insert 25 it will be a little shorter than 20 so you need to do watch winding motion with apical pressure to reach the full WL. [if you don't do this → ledge formation]

It is not a rule that you should enlarge by 3 files [if the canal is narrow you enlarge by 4 or 5 files and if the canal is wide → enlarge only by 2 files]

Step 2 : step back technique : enlarge 3 files bigger – none should reach the full WL – if MAF = 35 and WI = 20

- File 40 should reach 19 mm
- File 45 should reach 18 mm
- File 50 should reach 17 mm

Q: when BMP considered completed ?

- 1- Irrigate the canals and receive the irrigation by gauze [the color should be clear]
- 2- You should feel that the canals are smooth and clean and the **MAF should reach the WL passively**

if the file goes to the full WL but the master cone is short → this means the canals are not prepared enough → re insert the MAF and file a little bit until the MAF reaches the full WL passively

Q: what can you do if the MAF size 30 doesn't reach the full WL passively? You can file with a larger file 35 and 40 with force then size 30 will go passively.[this does not change the MAF it is still 30 – because it is the one that goes passively]

Irrigation : ** you should irrigate in between every 2 files

- Irrigants should be delivered deeply into the canals [insert the fine needle until you feel resistant then withdraw by 1mm] - don't inject when you feel resistance this could push the irrigant beyond the apex
- Irrigation should last 30 mins



- Irrigants mechanically clean the canals by removing the debris and also clean the canals chemically .

Chemically non active solutions

Sterile water
Physiological saline
Anesthesia solution

Chemically active solutions

NaOCl [antibacterial + tissue solvent]
CHX [anti bacterial]
H₂O₂ [oxidizing agent]
EDTA [chelating agent]

Combinations :

- NaOCl + CHX → brown precipitate
 - NaOCl + EDTA → no discoloration [but they inhibit each other]
 - NaOCl + citric acid → white precipitate that becomes cloudy after shaking
 - EDTA + CHX → cloudy blue
- If you are using different irrigation solutions you need to separate between them by using saline.

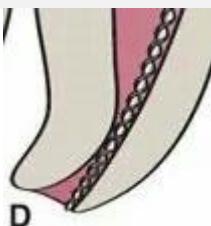
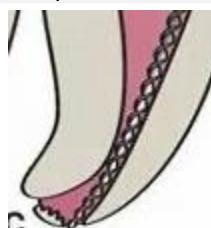
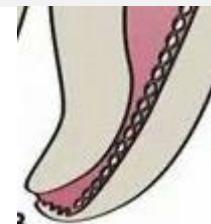
Q: how can you improve the efficacy of NaOCl? Warm the syringes at 60 ° C + use US tips [passive ultrasonic irrigation]

Final irrigation protocol : NaOCl for 1-3 mins → saline → EDTA → saline [do not use NaOCl again before obturation → this can lead to dentine erosion]



Accidents in root canal preparation

MISTAKE	CAUSE / NOTES
LOSS OF WL OVER INSTRUMENTATION	Blockage , ledge formation, broken instrument The file went beyond the apex → irritation to the peri apical region [mostly because of inaccurate WL]
OVER PREPARATION LEDGE	Canal walls are very thin – too much of the tooth structure is lost [can be because GG was used to prep the canals] Using files without pre curving – debris will fill the apical part and the file will go to a new WL
ELBOW	You pre curved the file in the wrong direction → a ledge in the curvature area → wide area before the apical constriction [You still have only one apical foramen] Corrected by proper irrigation then using injectable GP or warm condensation technique ** this widening is very difficult to clean + there will be lack of apical seal
APICAL TRANSPORTATION	If an elbow or ledge forms and you continue preparation → you will end up having 2 apical foramina
APICAL PERFORATION ZIPPING	A new apical foramen forms but without ledge or widening before the constriction [2 apical foramina are present] If an elbow or ledge forms and you continue preparation → widening of the apical foramen



Q: how can you avoid mistakes in root canal prep?

- 1- Select clear ref point + always observe the rubber stopper
- 2- Pre curve files when needed
- 3- File all walls
- 4- Always irrigate and recapitulate
- 5- Don't rush to bigger sizes
- 6- Check the length of the file before every insertion [the rubber stopper might have moved]
- 7- Discard files that show deformation
- 8- Remove all previous TF [leave the cotton pellet until you remove the TF completely to make sure that no debris goes into the canals]

Excessive filing is usually seen in the mesial walls of molars



Obturation - Tug back provides apical resistance and better sealing + prevents over extension of the cone

Mastercone is short

Irrigate and recapitulate or It might be due to under prep of the canals → file until MAF goes passively to full WL

Mastercone goes beyond the apex

Estimate how much of the master cone goes beyond the apex and cut it off – this way you ensure that you will have tug back
[you should put a mark on the cone corresponding to the ref point before you cut up the apical part – this point should not change after cutting]

Using a larger cone → might not go to full WL or might not have tug back

Mastercone has no tug back → make sure the cone doesn't go beyond the apex + make sure the accessory GPs reach the full working length - **or you can cut off the apical tip or use a larger cone that reaches full WL.**

Q: how do you determine which size spreader to use?

The biggest size that can reach the full WL or 2mm shorter [if the WL = 23 mm , appropriate spreader should reach 23 or 21 mm for the second insertion the spreader should go to 21 mm or 19 mm to be acceptable, if it is shorter by more than 2 mm → use a smaller size spreader] – with every insertion of the spreader you can accept 2 mm shorter than the previous length.

Q: what is the correct consistency of the sealer? After mixing and lifting the spatula the sealer should cut off when the spatula is 1- 1.5 cm away from the mixing slab

Sealer should be thicker in cases of open apex , and less viscous in case of narrow canals or so many lateral canals [best is to go for thick sealer in the master cone and less viscous for the accessory cones]

Accidents in obturation

- **Underfiling** = less than ideal filling [along the entire length of the root]
- **Short filing**= the obturation does not reach the apical foramen
- **Poor condensation** = the width of the obturation is not correct [can be due to poor condensation or under prep of the canals]
- **Over extension** = the GP is beyond the apex but apical portion is not well condensed
- **Over filling** = the GP is beyond the apex but the apical portion is well condensed [you don't need to do anything specially if the tooth was vital , the pt will only feel some pain due to PDL irritation for a few days]





Endodontic procedures- case selection

MEDICAL CONDITIONS AND ENDODONTIC TREATMENT

VALVULAR DISEASE AND HEART MURMUR	ABX prophylaxis – those pts are at risk of infective endocarditis secondary to dental Tx
HYPERTENSION	<ul style="list-style-type: none"> • Stress / anxiety can increase the chance of myocardial infarction • Antihypertensive drugs cause postural hypotension • Give short appointments and LA without vasoconstrictor [epinephrine]
MYOCARDIAL INFARCTION [MI]	<ul style="list-style-type: none"> • Elective endo should be postponed for at least 6 months • Give short appointments and LA without vasoconstrictor [epinephrine] • Minimize stress and anxiety [because they can precipitate angina] • If pt has pacemaker → don't use apex locator [it will cause interference]
PROSTHETIC VALVES / IMPLANTS	ABX prophylaxis – those pts are at risk of infective endocarditis secondary to dental Tx
LEUKEMIA	<ul style="list-style-type: none"> • Avoid treatment in acute phase** [check bleeding time and platelet count] • Avoid long appointments • ABX prophylaxis – pts at risk of opportunistic infections
CANCER	<ul style="list-style-type: none"> • Only emergency tx • ABX prophylaxis -pts at risk of opportunistic infections due to bone marrow suppression
HEMOPHILIA , THROMBOCYTOPENIA	<ul style="list-style-type: none"> • Avoid aspirin and medications metabolized in the liver • ABX prophylaxis
RENAL DISEASE	<ul style="list-style-type: none"> • Pt usually has hypertension and anemia [check BP before appointment] • ABX prophylaxis – pt is susceptible to infections • Screen bleeding time + avoid drugs metabolized in kidneys
DIABETES	<ul style="list-style-type: none"> • Increased tendency for infection + poor wound healing • Monitor glucose before appointment [pt should have breakfast/ normal dose of insulin] • Give early morning appointment + have glucose source ready • Do all elective procedures in the second trimester • Only emergencies in 3rd trimester and avoid supine position [can cause supine hypotension]
PREGNANCY	

4 things will determine whether you will do RCT or not:

- 1- Accessibility to apical foramen
- 2- Strategic importance of the tooth
- 3- Pt general health
- 4- Tooth restorability



Endodontic emergencies

- **Emergency** : situation associated with pain or swelling that requires immediate attention
- **rule of true emergency** = only one tooth is the offender.
- Emergencies usually affect sleep, working, concentration etc.
- Emergencies are associated with pain that started over a short duration and is un responsive to medication

Regardless of the situation you always :

- 1- Determine CC
- 2- Get full medical history
- 3- Clinical examination + pulp test + radiograph

Emergency	Clinical presentation	management
Acute pulpitis	<ul style="list-style-type: none"> - Pain - Vital tooth - Radiograph [RG] = normal - Caries / large restoration 	If you have limited time → Anteriors and premolars: pulp extirpation + dressing Molars : pulpotomy If you have enough time → Anteriors / premolars/ molars : pulp extirpation + dressing
Acute pulpitis with apical periodontitis	<ul style="list-style-type: none"> - Pain + TTP + tooth feels high - Vital tooth - Radiograph [RG] = normal or slight widening of the PDL or a small radiolucency 	If you have limited time → Anteriors and premolars: pulp extirpation + dressing Molar : pulp extirpation of the largest canal [palatal in the upper molars and distal in the lower molars] + call the next day to continue pulp extirpation of the other canals If you have enough time → Anteriors / premolars/ molars : pulp extirpation + dressing
Pulp necrosis Rarely an emergency	<ul style="list-style-type: none"> - Non vital tooth - No TTP - PA radiolucency 	<ul style="list-style-type: none"> - Pulp extirpation + dressing - Non restorable tooth → extraction
Acute apical abscess	<ul style="list-style-type: none"> - Swelling - TTP 	<ul style="list-style-type: none"> - Drainage through the canal OR Incision and drainage if the swelling is large and fluctuant ** LA infiltration around the periphery of swelling then incise at the areas of max fluctuance down to the level of bone. – vertical incision provides better post op healing [position the incision that will aid drainage by gravity] Keep the wound clean and promote drainage by hot salt water mouth rinses . - Systemic complications → ABX
Diffuse swelling		<ul style="list-style-type: none"> - Access the tooth + instrument the canal + irrigate - if there is no drainage → instrument beyond the apex to encourage drainage from PA tissues - If drainage through the canal fails → I & D + drain placement ** CNS changes / toxicity / compromised airway → hospitalization



- **Location of the swelling will depend on :** location of the tooth apex in relation to muscle attachments to the maxilla or the mandible.

Antibiotic guidelines:

select the ABX with anaerobic spectrum + larger dose for a short duration

ABX only given for pt's with systemic manifestations [fever, malaise, cellulitis, lymphadenitis]

Importance of incision and drainage:

- 1- Drain and evacuate the bacteria and their toxins
- 2- Relieve pressure → pain relief
- 3- Prevent further spread of the infection

Antibiotics [if indicated]	
ABX	Dose
Penicillin VK	Initial dose 1-2 g then 500mg every 6 hours for 7-10 days
Penicillin + metronidazole	250 mg for 7- 10 days
Clindamycin For pts allergic to amoxicillin	300mg followed by 150 to 300mg every 6 hours for 7-10 days.

Analgesics			
	Mild pain	Moderate pain	Severe pain
Aspirin like drug indicated	Ibuprofen 200-400 mg	Ibuprofen 400-600 mg OR Ibuprofen 400-600 mg + acetaminophen 650 – 1000 mg	Ibuprofen 600 – 800 mg + acetaminophen 1000 mg
Aspirin like drug contraindicated	acetaminophen 650 – 1000 mg	acetaminophen 650 – 1000 mg + equivalent of codeine 60 mg	acetaminophen 1000 mg + equivalent of oxycodone 10 mg



Single visit endodontics

Most studies showed no difference in post op pain and success rates between single visit and multiple visit endodontics.

Advantages of single visit	Disadvantages of single visit
<ul style="list-style-type: none"> 1- Pt comfort [less visits and less LA] 2- Saves time [only one visit] 3- Minimizes incomplete treatment 4- Constant WL , you are still familiar with the canal anatomy 5- Minimizes fear and anxiety 6- No risk of bacterial leakage in between appointments 	<ul style="list-style-type: none"> 1- Pt fatigue [opening for a long time] 2- Clinician fatigue 3- Needs experienced doctor 4- If a flare up happens it is difficult to establish drainage 5- Not possible in all cases [weeping canals, calcified canals , severely curved canals etc] 6- You can't place intracanal medications [you depend only on the action of NaOCl]

Indications	Contraindications
<ul style="list-style-type: none"> 1- Uncomplicated cases of VITAL teeth 2- Physically impaired pts that cant come multiple visits 3- Medically compromised pts that require ABX prophylaxis 4- Fractured anterior where esthetics is a concern 5- Un complicated cases of non- vital teeth with sinus tract [<i>tract because they rarely flare up + the sinus tract will drain preventing accumulation of pressure and pus</i>] 6- Pts requiring sedation 7- Apprehensive but cooperative pts 	<ul style="list-style-type: none"> 1- Acute abscess 2- TTP 3- Non vital tooth 4- Calcified / curved canals 5- Limited mouth opening [TMJ pts] 6- Limited accessibility 7- Retreatment cases



Latest advancements in endodontics

Advancements in diagnosis:

- 1- **Pulp vitality tests:** [indicate if the pulp has blood flow or not] – more accurate than sensibility tests [**pulp oximetry, laser doppler flowmetry**]

Pulp oximetry:

non invasive – measures oxygen saturation of blood

sensor is modified to be placed over the tooth – detection of a pulse → pulp is vital

**oxygen saturation values from the teeth are lower than the readings from the patient's finger

Advantages

No painful stimulus

No previous calibration

Not affected by age and physical condition of the pt

Disadvantages

Difficult to find a probe that fits all teeth



- 2- **CBCT:** can be –

- **Limited (dental or regional)** - scans only 2-3 teeth -mainly used in endo [**higher resolution + lower radiation**]
- **Full (ortho or facial)** – scans full head and neck

CBCT can be used to:

- 1- Get more accurate canal measurements
- 2- Know exact direction of root curvature [PA will only show mesial and distal curvatures, CBCT shows buccal and lingual]
- 3- look for calcified, missed and accessory canals
- 4- Evaluate fractures/ root resorption/ perforations [a PA will only show mesial and distal perforations]

Digital impression + CBCT + 3D printing → makes a stent to negotiate calcified canals without perforations

Advancements in root canal prep :

Access cavity:

- A. **Conical carbide burs :**

Self centering – safer and less invasive → will allow you to find calcified canals better than round burs.

- B. **Ultra sonic tips:** [can be used in every step of RCT: access, irrigation, obturation]

Used for: access refinement and finding calcified canals

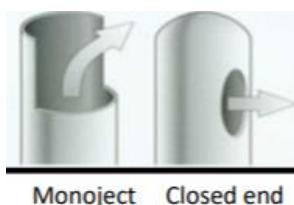
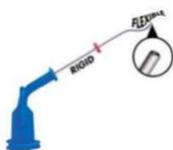
removal of attached pulp stones / removal of posts / removal of broken instruments

- C. **Terauchi file removal kit (TFRK) :** to remove broken instruments

Root canal irrigation:

MANUAL :

- A. **Monojet and closed end needle designs** : prevent irrigants from going beyond the apex
- B. **Navitip** : a small flexible cannula [only the last 5 mm is flexible] that is used to deliver irrigants and sealer into the canal – easily inserted into the apical 3rd and curved canals
Needle = closed end
Navitip FX: smaller than Navitip + the needle is double side port [irrigation goes from both sides]
- C. **Manual dynamic agitation**: after instrumentation and confirming tug back – insert the master cone with few drops of irrigants and move the cone up and down few times [done as the last step before obturation]
- D. **Endobrush**: Can't be used till working length + cause dislodgement of radiolucent bristle



MACHINE ASSISTED :

- A. **Rotary brushes**
- B. **Quantec – E** : continuous irrigation during rotary instrumentation
- C. **Sonic devices** [frequency below 20 kHz]
- D. **Ultrasonic devices** [frequency above 20 kHz]:
Active ultrasonic irrigation: ultrasonic irrigation + instrumentation at the same time [no longer used – because when the US tip came in contact with the walls → created more debris]
Passive ultrasonic irrigation: the tip does not touch the walls
Irrigate then → Place a size 15 K- file inside the canal → touch the file with the US tip [done for 20 seconds then change the irrigants – total time 1-3 mins]
- E. **Endovac system**: applies -ve pressure inside the canal – you guarantee that the irrigants reached the apical 3rd
you irrigate the canal and then insert the cannula , the cannula will apply -ve pressure at the apical part of the canal [the irrigation will move from the pulp chamber to the apical part and then sucked out of the tooth]
Less PA extrusion of irrigants and less Post op pain
Better irrigation and debridement 1 mm away from the apex
Can relieve pressure from a PA abscess
- F. **RinsEndo system**: applies +ve and -ve pressure cycles inside the canal [higher risk of apical extrusion]
- G. **Lasers** : Co2 & Er: YAG [effective in melting the smear layer + seal DT] – **BUT STILL INFERIOR TO NaOCl IRRIGATION**

Q: what can you do to improve your irrigation protocol?

- 1- Use a fine needle [yellow]
- 2- Insert the needle deep into the canal until you feel resistance then withdraw 0.5- 1mm and irrigate
- 3- Heat NaOCl in a water bath at 60°C [to increase its antimicrobial and tissue dissolving effect]
- 4- Build the broken walls of a tooth to keep the irrigants inside
- 5- Passive ultrasonic irrigation [PUI] [the energy will warm the solution + cause vibrations → lebris]





Cleaning and shaping:

A. Rotary files:

- **Patency files:** create a space before the use of rotary shaping files – they were invented to eliminate the use of hand files and reduce their errors.
 - > faster in creating space for rotary shaping files
 - > cause less canal transportation
 - > more suitable for curved canals
 - > can compensate for the lack of experience resulting in more conservative shaping

- Rotary files = non- active tip
- K file = active tip
- Second generation patency file = semi active tip

first generation patency files [path file]: 3 sizes (10,15,20) – constant taper

second generation patency files [Proglider] : one file , multiple taper with **semi active tip** – the file is made from **M- wire Niti Alloy** [has reduced cyclic fatigue and more flexibility → can be used in very curved canals]

**** if you are using proglider you need to check WL 2 times [before using and after using the file]-** because if the canal is very curved the file can change It's curvature and change WL

****before using the patency files scout the canal with a size 10 file and obtain WL → use the patency file to the full WL → reconfirm WL**

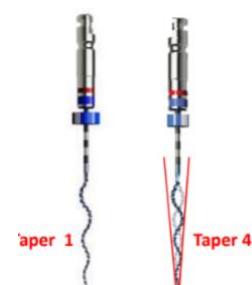
- **Shaping files :** need pre existing space, they can't be used to make space [you create this space by using manual files up to size 15 or 20].

**When you are using the hand files to create space, you can still cause a ledge, perforation or zipping.

Niti – alloy : the material has different properties at different temperatures

Martensite	R phase	Austenite
At cold temp Excellent fatigue resistance	Intermediate phase [all files now are made at this phase] Companies either change the duration of the R-phase or at it temp it occurs	At hot temp Excellent shape memory Great cutting efficiency , edge fidelity, torque resistance

- When you see M- Wire it means the martensite ratio is more.
- CM wire = controlled memory wire
- Max wire technology = the file is M phase at room temp and A phase at body temp – the curves increase in size [Ex: XP endo shaper, XP endo finisher]



XP – endo shaper file:

- Max wire technology
- Before using XP endo shaper → prepare the canal to size 15
- Self adjusting
- Since the curves increase at body temp → this ensures that the touch all walls of the canals → better cleaning



Self adjusting file [SAF]: flexible and has a hollow core, it adapts itself according to the shape of the canal + provides continuous irrigation during instrumentation

Single file systems	
Full rotation	Reciprocating rotation
One shape, One curve, XP endo shaper	wave one, waveone gold, reciproc, reciproc blue

Gentle wave system: Prepare the canals to size 15 then insert the sterile handpiece inside the canal – the hand piece will irrigate [NaOcl then saline then EDTA for 4-5 mins] + provide high energy waves that will effectively clean the canals then provides negative pressure to suck the irrigant out.

- **Gentle wave system has a very high success rate and does not cause post op pain [because there is no mechanical instrumentation & no apical trauma + the -ve pressure will prevent apical extrusion of irrigants]**



Rotary endodontics

Gates Glidden burs: [GG]

- 6 sizes [you know the size from the number of stripes on the shank of the bur]
- When using GG **stripping perforation mostly occurs in the distal wall of the mesial root of lower molars** – this can be prevented by using the GG in a brushing motion against all walls.



Advantages	Disadvantages
Easy to use Inexpensive Easy to retrieve if it breaks	Can cause ledges / stripping Cannot be used in curved canals Aggressive + remove a lot of tooth structure Difficult to seal the coronal 3 rd of the canal if you are using lateral condensation

NiTi rotary instruments:

Similarities	Differences
1- All made from same alloy [NiTi] New advancement: heat treated alloys → better flexibility and resistance to cyclic fatigue 2- All need a specific engine motor [slow speed and controlled torque] 3- All are used in crown down technique 4- Have non cutting tips	1- Sizes 2- Taper [increase in diameter of the file for every 1 mm increase in length] 3- Cross section & tip design 4- Length of the cutting blade and number of spirals

** Rake angle = angle formed between the radius of the file and the cutting edge.

- Cutting edge is exactly on the radius → zero rake angle
- Cutting edge in front of the radius → +ve rake angle [cutting action]



- Cutting edge behind the radius → -ve rake angle [scraping action]

Tapers in endo instruments explanation:

Taper = how much the diameter of the file/ instrument increases with every 1 mm increase in length

Manual files	Rotary files
<p>Have only constant taper [constant increase in their diameter, but the increase is small] Ex: 2% taper means that with every 1 mm length increase the diameter increases by 0.02 mm 4% taper the diameter increases by 0.04 mm etc.. Ex: file size 25 with taper 2 % what will the diameter be at D3? $D_0 = 0.25 \text{ mm}$ $D_1 = 0.27 \text{ mm}$ $D_2 = 0.29 \text{ mm}$ $D_3 = 0.31 \text{ mm}$</p> <p>In hand instruments the taper is small otherwise the friction will be very high and you can't use the file.</p> <p>** we try to decrease the number of contact points between the file and the canal walls to avoid taper lock which can break the file or the dentine walls.</p>	<p>Can either have constant taper or multiple tapers</p> <p>Constant taper : [constant increase in their diameter , but the increase is large – up to 8- 10% taper]</p> <p>Multiple taper: the increase in diameter is not constant Ex: Taper from $D_0-D_1 = 2\%$ [diameter increases by 0.02 mm] Then taper from $D_1-D_2 = 3\%$ [diameter increases by 0.03mm] From $D_2 -D_3 = 4\%$ etc..</p> <p>Reverse taper : the large taper is at D_0-D_1 and then it decreases as you go more coronally</p>

- D_0 = the tip of the file
- D_1 = 1 mm away from the tip
- D_2 = 2 mm away

Hand files have 3 lengths [21 mm, 25 mm , 31 mm] but regardless of the length of the file the length of the active part is ALWAYS 16 mm only [located at D16]

In rotary the length of the active part is variable but the maximum is 14 mm [located at D14]

benefits of multiple tapers:

- Increase file elasticity
- Increase cutting ability
- No need for recapitulation during prep
- Decrease torsion and number of files in the system

Rotary instruments motions

Delivered by the file	Delivered by the operator
<ul style="list-style-type: none"> • Full rotation • Reciprocation 	<ul style="list-style-type: none"> • Beck motion [up and down] • Brush motion



Thread tendency :

The cutting edges in the rotary files are continuous helices → this leads to thread tendency [the feeling of the file sinking inside the canal when you want to remove it , at this point if you don't stop the rotation the file will break] – Thread tendency is mostly experienced when you are doing back motion and the file rotation is full rotation

- If the helicals are placed parallel to each other [constant helical angle] → higher thread tendency
- If the helicals are not parallel [variable helical angle] → lower thread tendency
- > Adv of thread tendency: allows the file to reach the apical part easily
- > Disadv of thread tendency: the file can break

Q: why is it better to use rotary files?

- 1- Faster preparation
- 2- Provides the desired shape of the canal [continuous tapered conical form]
- 3- Lesser chance of perforations, apical transportation and zipping
- 4- Centered preparation

Q: what are the disadvantages of rotary files?

- 1- Higher risk of fracture compared to k files
- 2- Might create micro cracks in the dentine
- 3- Can't be used in curved narrow canals
- 4- Don't clean oval / wide canals very well. [fixed by doing brushing motion]

why do rotary files have less complications? Because they have non active tip + they are made from nickel titanium alloy [flexible]

heated treated niti alloy systems are more flexible and can be used in curved canals.

Rotary files can be used in all RCT cases EXCEPT: narrow canals, C or S shaped canals, oval and wide canals.

C or S shaped canals : use manual filing and focus on irrigation



Clinical procedure of using rotary systems: ALWAYS FOLLOW MANUFACTURER INSTRUCTIONS REGARDING TORQUE, SPEED AND SEQUENCES OF FILES

Protaper system [FULL ROTATION]

- 1- Access cavity + WL estimation
 - 2- Insert S1 file [it is okay if it doesn't reach the full WL]
- ** S1 is used before SX because the tip is thinner and the file is more flexible
- 3- Insert Sx file to prepare the coronal part of the canal
 - ** if you didn't take WL you should do it NOW.
 - 4- Use S1 file again [but now it has to go to the full WL]
 - 5- Use S2 → F1 → F2 → F3 file
- **Lubricate the files with EDTA + irrigate properly with NaOCl
** small canals you can stop at F1
** use each file for max of 10 seconds

Wave one [RECPORICATING ROTATION]

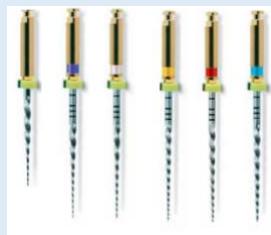
- 1- Access cavity
 - 2- Select appropriate file size
Insert a 10 k file
If it is stiff or doesn't reach WL → use yellow wave one file
If 10 k file is loose, insert 20 k file → if it is stiff or doesn't reach WL → use red waveone file
If 20 k file is still loose → use black waveone
- **Lubricate the files with EDTA + irrigate properly with NaOCl
- 3- Use the files in a crown down technique with beck motion 2-3 times then remove the file irrigate and repeat
- ** to know if you cleaned the canals well enough- insert the matching k file to the rotary file you used.
[red waveone = 25 k file, black waveone = 40 k file]
If the k file goes to the full working length PASSIVELY and has tug back apically → you are ready for obturation.
If the k file is loose → go for a bigger file size
If the K file can't reach full WL → use the wave one again in brushing motion

Protaper system has 6 files

3 shaping files [Sx, S1, S2] – multiple taper

3 finishing files [F1,F2,F3] – reverse taper

If the file has been used before make sure you do brushing motion because the file decreases in diameter with use.



Wave one has 3 files

Yellow = small

Red = primary size [used in most cases]

Black = large

the file moves in one cycle clockwise and counterclockwise and every 3 cycles completes one full rotation



** SINGLE USE SYSTEMS = disposable files – if you sterilize them they change dimensions and don't fit into a hand piece again. [files might be contaminated with **prions** from the pulp tissue , prions will not be killed by sterilization] – **single use systems reduce chance of fracture**

** SINGLE FILE SYSTEM = you can finish the canal prep using one file only



Latest advancements in obturation

If at the time of obturation you saw that the TF is dislodged and there is communication with the oral cavity → irrigate , place medication and postpone obturation

Obturation techniques

OBTURATION TECHNIQUES

LATERAL COMPACTION	<p>Cannot be used in [curved narrow canals, internal resorption, canals with irregular shape]</p> <p>The master cone should have tug back ** [if there is no tug back the master cone will move out of the apex during condensation]</p> <p>Uses a heat carrier [to warm the GP] and pluggers</p> <p>Procedure:</p> <p>Cut the master cone at the canal orifice → heat the heat carrier by any source of fire and insert it into the coronal part of the canal → use the plugger for the coronal part then repeat as you go to the middle and apical part using different size of pluggers.</p> <p>The final plugger should be 5-7 mm shorter than the WL</p> <p>After you achieve good compaction of the apical 3rd you fill the rest of the canal either by the same procedure or using injectable GP / backfill.</p> <p>ADV: excellent sealing of the canal apically and lateral / accessory canals DISADV: larger pluggers can bind the canal and split the root + lip burning from the heat carrier + difficult to master</p> <ul style="list-style-type: none"> • Touch' n heat [Sybron endo] is an electric heat carrier that was later invented and reduced the chance of lip burning and the need for torches <p>warm vertical condensation but not done by hand instruments it is done using system B</p> <p>procedure: Cut the master cone at the canal orifice → in one motion – push the tip smoothly until you reach the binding point [Heat delivery should stop 2-3 mm before you reach the binding point by you need to keep on pressing with the tip to compensate for the shrinkage that might occur when the heat stops] → reheat the plugger for one second to release the GP and remove the plugger</p> <p>After you achieve good compaction of the apical 3rd you fill the rest of the canal either by the same procedure or using injectable GP / backfill.</p> <p>Binding point = the point of contact b/w the tip and the canal wall</p> <p>ADV: excellent seal [including lateral canals] +less technique sensitive + no need for separate pluggers and heat carriers the tip does the work of both + the tip used can deliver the exact heat for a long time [in hand instruments the plugger can be very hot at first then cool down] + can be used with standardized/ non standardized / rotary GP</p> <p>A heated spreader is inserted lateral to the cones → un heated larger spreader is inserted → insert accessory GP until obturation is completed</p> <p>ADV: no need for special GP or instruments + Heat is not introduced to apex+ Precise GP length control + Potential for root fracture is reduced</p> <ul style="list-style-type: none"> • Endotech – one button heats the tip to warm the GP laterally then another button will cause vibrations • Enac - the tip only delivers vibrations which are enough to heat the GP <p>You can achieve the same effect if you touch the side of the spreader with an US tip → vibrations and heat</p>
WARM VERTICAL COMPACTION [WVC] [SCHILDER'S TECHNIQUE]	
CONTINUOUS WAVE [SCHILDER'S TECHNIQUE LATER BECAME CONTINUOUS WAVE]	
WARM LATERAL CONDENSATION	



INJECTABLE GP [THERMOPLASTICIZED INJECTABLE TECHNIQUE]	<p>Ex: obtura , ultrafill, calamus Definite apical stop is needed Indications:</p> <ul style="list-style-type: none"> - abnormal canals with many irregularities [ramifications, C / S shaped canals] - internal resorption - back filling of canals after WVC or continuous wave <p>procedure: choose appropriate size of tip [appropriate size is a tip that is 3-5 mm shorter of the WL] → apply sealer and inject warm GP inside the canal allowing the back pressure push the needle out of the canal [do not resist this pressure] → use pluggers dipped in alcohol [to prevent it from sticking to the GP] → compact the GP</p> <ul style="list-style-type: none"> • Guttaflow : you inject it inside the canal + you place a master cone [easier to remove for retreatment and post preparation] 	
THERMO MECHANICAL TECHNIQUE MC SPADDEN COMPACTION	<p>Compacter looks like a reveres H file Insert the master cone then insert the compacter into the canal [the energy delivered will melt the GP and the threads of the compacter will direct it apically] DISADV: can't be used in curved canals the compacter breaks easily + canals are usually over filled when using this technique</p>	
CARRIER BASED TECHNIQUE	<p>Ex: soft core , dense fil Consists of a flexible steel, titanium, or plastic carriers coated with GP The match between the file and the cone must be perfect – the kit has a file called size verifier [SV] to verify which size of GP to use If the SV fits → use same size obturator If the SV does not fit → use this SV to continue the prep or use a smaller SV ADV: easy single insertion + excellent seal + quick DISADV: needs apical stop + can't be used if you need to place a post + difficult in case of re treatment</p> <ul style="list-style-type: none"> • Gutta core : GP core coated with another type of GP – the core comes out efficiently & no plastic core remains in the canal [easier in case of retreatment] 	
CHEMO PLACTIZED TECHNIQUE	<p>Indication: very wide canal with open apex Procedure: many GPS stuck together to form a braided cone → insert the GPS in [chloroform, eucalyptol or halothane] → the solvent will soften the outside of the GPS → insert the GPS into the canal and take it out several times [each time dip it in solvnet again] until you reach full WL → the GP will take the shape of the canal → clean the GP with NaOCl → apply sealer and insert</p>	



Apical barrier

Q: how can you make an apical barrier for immature roots with open apex?

- 1- Dentine chips / MTA (best) [permanent solution]
- 2- CaOH₂ [temporary solution]

Dentin apical barrier:

Proper cleaning and removing of all debris → with GG or a hand file
create dentine chips 1 mm shorter than the WL → pack the chips with a paper point of create an apical barrier of 1-2 mm od dentine chips → canal is obturated with a GP over the dentine chips

DISADV: further weakens the tooth + some inflamed pulp tissue might still be inside the debris

MTA apical barrier:

insert the MTA apically using messing gun or a special carrier [better under microscope]

ADV: biocompatible + can be used in wet areas + bacteriostatic

DISADV: long setting time + difficult to manipulate



Restoration of endo treated teeth

Endo treated teeth are more prone to fracture because of decrease in structural integrity NOT because loss of moisture. [there is no difference in moisture content between endo treated teeth and vital teeth]

Decreased in structural integrity happens because:

- 1- Loss of tissue [removing caries, previous restorations, fractures , looking for MB2 canal, access cavity and canal shaping etc]
- 2- Changes in flexural strength of dentine caused by irrigation solutions

Q: when should you restore an endodontically treated tooth? Ideally ASAP, but if you doubt the prognosis of the tooth wait until you see clinical / radiographical evidence of healing then restore the tooth.

Q: what factors affect your decision of when and how you should restore and endo treated tooth?

- 1- **Restoration material to be placed** [amalgam / composite can be placed after obturation because they are easy to remove in case of failure – but you should wait until you confirm healing before placing posts and crowns because they are harder to remove in case of failure]
- 2- **Quality of the obturation** [if you have poor RCT and poor healing → re Tx , if you have poor RCT but good healing you can go ahead with a direct restoration but you must re Tx if you are going to place crowns]
- 3- **Pre existing endo status (Presence / absence of PA changes)** : [will also guide you whether you need re Tx or not]
- 4- **Location of the tooth in the mouth** [anterior teeth need to be restored after obturation for esthetics]

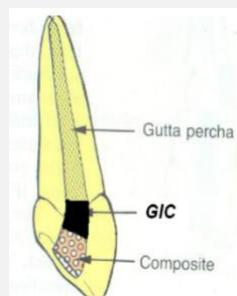
Q: Do you need to crown every RCT tooth? No, crowns are only needed if there is high risk of fracture of the tooth [anterior teeth can be crowned to improve esthetics]

Minimal coronal damage

Anterior tooth:

Intact marginal ridges
Intact incisal edge and cingulum
Small proximal fillings

Restore the access cavity with GIC then composite [GIC will provide better sealing because it chemically bonds to the dentine + act as a barrier between the zinc oxide based sealer and the composite]



Significant coronal damage

Anterior tooth:

Loss / undermining of marginal ridges
Loss of incisal edge / Fractures
Large proximal fillings

- 1- Restore the tooth with a filling [if the structure is retentive enough with favorable occlusion]
- 2- Crown
- 3- Post + core + crown
- 4- Nayyar core



** make sure that you clean the coronal area from any GP or sealer to prevent discoloration later on

Posterior tooth:

Intact walls / cusps

- 1- Direct composite restoration
- 2- In lay

Posterior tooth:

lost walls / cusps

- 1- Endocrown
- 2- Full crown
- 3- Post + core + crown
- 4- Nayyar core

NOTE: if you are placing a restoration in the same session, you can remove the sealer coronally using US devices or better wait until it dries then remove it

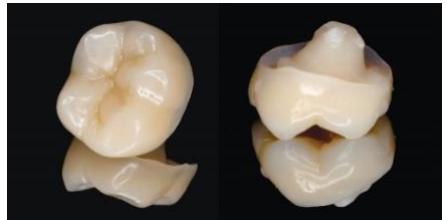
Post and core:

Indications:

- 1- If the remaining of the tooth structure **does not provide sufficient retention** for a restoration
- 2- If the palatal wall of maxillary anteriors is lost [prevented by making your access cavity more incisally]
- 3- If the labial wall of the mandibular anteriors if lost

Common mistake during accessing through a PFM crown is making the access too palatal to preserve the porcelain on the incisal edge → little palatal wall remains → this will fracture the dentine core and will lead to loss of the crown [better to remove the crown before accessing to be able to place the access cavity more incisally and preserve the palatal dentine]

Endocrown: uses the pulp chamber for retention

Indications	Contraindications
<ol style="list-style-type: none"> 1- Inadequate clinical crown height 2- Inadequate thickness of the tooth walls 3- Inadequate inter occlusal space 4- Inadequate ferrule 5- Teeth with very narrow slender roots [you can't place posts] 	<ol style="list-style-type: none"> 1- pulpal chamber is less than 3mm deep 2- if the cervical margin is less than 2 mm wide for most of its circumference 3- Long clinical crown height 

**Endocrown preparation:**

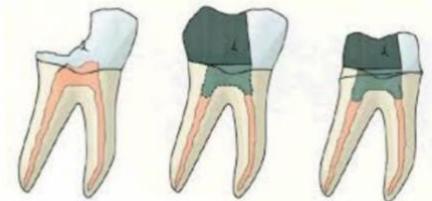
<https://www.youtube.com/watch?v=1rFkRIWQaM4>

2 mm occlusal reduction → remove undercuts in the access cavity + make the coronal pulp chamber continuous with the access cavity → polish to remove irregularities and produce a flat surface



- Use a non abrasive instrument to remove 2 mm of the GP from the orifice of each canal [this will improve retention]
- Cementation with resin cements [rely X]

Nayyar Core: a core created inside the pulp chamber and the canal entrance

**Amalgam: placed posteriorly**

Advantages	Disadvantages
Least technique sensitive Cheap Can be condensed into undercuts	Poor esthetics – applied only posteriorly Corrosion and galvanic shock

Composite resin / GIC : placed anteriorly [must be covered with a crown]

Advantages	Disadvantages
Esthetics + ease of placement	Technique sensitive Degrades with time

Post and core :

- The only advantage of the post is to retain the crown
- The post weakens the tooth and makes it more prone to fracture + makes re treatment more difficult
- Fiber posts have similar physical properties like dentine → they can reinforce the tooth and have less chance of fracture
- **Post indications have different classes :**

Post is not indicated in class I [4 walls remaining] and not indicated in class II [3 walls remaining] or III [2 walls remaining] **if you are using adhesive restorations**

Post is indicated in class IV [one wall remaining] and class V [no walls remaining]



Post indications	Post contraindications
when you can't do an endocrown when you have one or no walls remaining	Small narrow canals , curved roots Alternative : nayyar core + crown anteriorly or Nayyar core + endo crown/ crown posteriorly



If you don't have 2 mm ferrule
[you can obtain a ferrule by ortho extrusion or crown lengthening]

Ways to obtain a ferrule of 2 mm :

Crown lengthening

Faster – can be done in one session

Soft tissue removal : done if you'll still have at least 1 mm of sulcus after trimming

Bone contouring: if you can't keep a 1mm sulcus after trimming → remove bone

EX: if the pt has 1 mm of crown height and a sulcus of 2 mm → just do gingivectomy to gain 1 mm of crown height and keep 1 mm of sulcus depth

DISADV:

- Asymmetry of the gingival margin [should be avoided in pts with gummy smiles – the asymmetry will show]
- Causes unfavourable increase in crown to root ratio
- Can cause damage to bone of adjacent teeth → makes implant placement harder later on because the lost bone cannot be regained

Orthodontic extrusion

Takes 2 – 3 weeks

Contraindicated in:

- 1- short roots
- 2- If the extrusion will result in furcation exposure
- 3- Inadequate prosthetic space

Avoid crown lengthening if :

A. Pt has gummy smile → the asymmetry of gingival margin will show

B. You are unsure of the prognosis and the pt might need implants later → the bone lost cannot be regained and this will make implant placement harder

Procedure of post and core: [remove GP – prepare space for post – prepare coronal tooth structure]

1- Removal of the GP : 4-5 mm of GP should remain apically

- if you decided to go for post and core while you are doing the RCT:
Do partial root filling – you only fill the apical 5 mm [easier with vertical condensation than lateral condensation]
You cannot obturate completely and then remove the GP and prepare for the post in the same session because the sealer has to be completely set before you remove the GP otherwise it will disturb the apical seal.

- if the canal is previously filled and the tooth is now indicated for RCT:
GP can be removed by :

- A. heat :
using heated endo probe / plugger
the tip of a system B or touch n heat device

- B. solvents : used only in the coronal part of the canal never apically



chloroform, methyl chloroform, benzene , xylene, eucalyptol oil , halothane

- C. hand instruments [always needed with heat or with chemicals]

K file is inserted to create space above the root filing then GP is removed with **H file or S file** [better because less chance of fracture and safer to use]



- D. micro debrider : small files with 90° bends to remove any GP remaining on the walls on the canal.

E. rotary instruments:

- ◆ **Gates Glidden** : mostly used coronally – inserted for 2-3 mm then pulled out [it will remove a little bit of GP with it and soften the remaining GP for easier removal]
it is also used to create space for hand instruments or solvents
- ◆ **rotary files that have active tips**

The best method to remove GP is US tips under microscope magnification

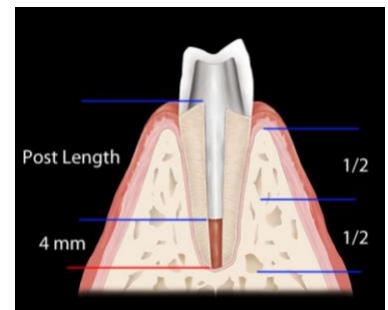
2- prepare the post space:

- determine the size of the canal
- prepare the space for the post using peeso reamers or parapost drills [the drill size corresponds to the post size]
- place the post inside the canal and check by xray

Factors affecting post retention:

A. post length [most imp factor]

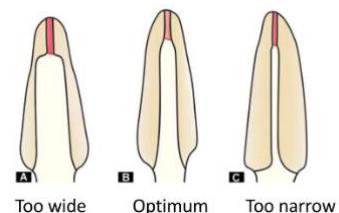
- the greater the post length the greater the retention and the better the distribution of forces
- more important than diameter for retention
- should be 1 / 2 to 2/3 of the root length - **minimum post length = the length of the crown**
- leave apical seal of 4-5 mm [failure to leave an apical seal → RCT failure]
- the post should extend 4 mm apical to the crest of the bone to decrease stresses in the dentine and in the post [otherwise you'll have fracture of the tooth cervically]
- if the canal has a curvature → insert the post up to the point where the curvature starts



B. post diameter:

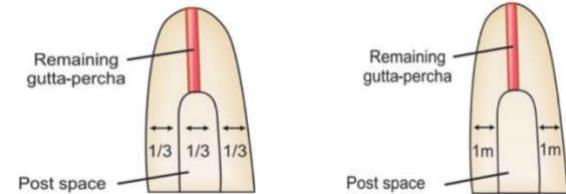
too narrow → post will fracture

too wide → root will fracture





post diameter should not exceed 1/3 the diameter of the root [1 mm of sound dentine should be maintained circumferentially]



post designs :

Parallel	More retentive but can cause root fracture apically [because the canal is tapered]
Taper	Can create wedging effect [focus occlusal forces towards the apical region] leading to root fracture
Parallel / taper	Parallel coronally and tapered apically

**** parallel is more retentive than tapered , threaded is more retentive than cemented – cemented posts distribute the forces better**

Cements : conventional zinc phosphate and zinc polycarboxylate cements have little effect on retention but if you use adhesive resin cements you can improve retention

Cementation:

- 1- Dry the canal [very imp]
- 2- Place the cement inside the canal and on the post and insert the post with least pressure
 - Posts in anterior teeth have higher failure rates because they are subjected to different types of forces , in posterior teeth the forces are more parallel to the tooth → higher success rate

Q: what are some common mistakes during post preparation?

- 1- Disturbance of the apical seal [you remove all of the GP]
- 2- Perforations
- 3- Over enlargement of the canal space
- 4- Extrusion of the obturation material
- 5- Separated instrument

3- Preparation of the coronal structure:

Be conservative – remove unsupported tissue [maintain ferrule effect]
 [cast post = you need to remove undercuts , prefabricated post = no need to remove undercuts]
 Custom made cast post and core needs anti rotational notch

IMP NOTE : post + core are used when you don't have enough tooth structure to retain a restoration but you still need ferrule of at least 1.5 – 2mm.

Q: why is the ferrule needed even if you are placing a post and core? Posts cause wedging effect , the ferrule will separate between the crown and the post → prevent root fracture

- Posts can be passive → retained only by cementation
- Active → retained by threads engaging into the dentin + cementation

Post Length	Minimum same length as clinical crown
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	Or at least 1/2 - 2/3 of root length
Post diameter	Should not exceed 1/3 root diameter 1 mm of sound dentine circumferentially
Apical seal	4 - 5 mm



Bleaching of vital and non vital teeth

Stains :

- 1- Extrinsic [good prognosis] – chromogenic bacteria adsorbed into plaque
 - A. Non metallic stains: coffee and tea, smoking, CHX stains
 - B. Metallic stains:
 - occupational exposures: iron → black stain / copper → green stain
 - Dietary supplements: iron supplements should be taken for few weeks then stopped for few weeks before they can be taken again
- 2- Intrinsic [fair prognosis] – occurs during tooth formation or after eruption [ex: fluorosis, tetracycline staining, dentino / amelo genesis imperfecta , enamel hypoplasia , trauma, obturation material remnant, pulpal remnant, iodine containing intracanal medications (metapex)]
- 3- Age related : due to thinning of enamel + 2° dentine deposition + prolonged exposure to staining agents

Q: why do traumatized teeth get discolored? Hemoglobin from bleeding breaks down to hemosiderin and causes staining

Q: how does bleaching work? It is a redox reaction , the bleaching agent gets reduced and releases free radicals to oxidize the stains

Bleaching agents:

- 1- Hydrogen peroxide :

Hydrogen peroxide can break in 2 ways:

- A. Into water and nascent oxygen [weak radicals] – in the presence of moisture
- B. Perhydroxyl and hydrogen [strong radicals]

Q: why should the teeth be dry before application of H₂O₂? To get more perhydroxyl radicals that are stronger and give better bleaching [moisture will cause H₂O₂ to give water and nascent oxygen which are weak radical and don't bleach well]

- 2- Carbamide peroxide : gives urea which will later give CO₂ and ammonia [the high PH of ammonia is what causes the bleaching]
Needs to contact the tooth surface for longer time – better tolerated for home bleaching

3 % hydrogen peroxide = 10 % carbamide peroxide

Q: how can you increase bleaching efficacy?

- 1- Increase peroxide concentration
- 2- Increase gel temp
- 3- Increase duration of exposure to tooth

Overbleaching will increase enamel porosity → anything the pt drinks or eats will cause staining [management: apply fluoride to remineralize the tooth surface]



Instruct the pt to stop home bleaching when they stop seeing any significant color change [aim for a color to match the white in their eyes]

Q: what are the most common side effects of bleaching? Sensitivity then gingival irritation

Q: a pt asks you what is the best home bleaching agent , what do you reply? Look for any product that has the ADA seal of acceptance

** ADA seal of acceptance means the company did safety studies on the product + at least 2 clinical trials that showed at least 2 shade difference

Home bleaching : [gives the best results]

- A. 10% carbamide peroxide in a custom tray [adding carbapol will extend it's action for 8 hours → can be used overnight]
- B. Whitening strips containing H₂O₂ [H₂O₂ action is only 30 mins]
 - In the initial stages of bleaching teeth might white spots or too white in general → this becomes less with time

Q: what instructions do you give to the pt to reduce sensitivity after home bleaching?

Brush with potassium nitrate toothpaste for 2 weeks before bleaching + placing the desensitizing toothpaste in the tray and wearing it for 30 mins daily for a week before bleaching. Or the pt can use CPP- ACP desensitizing agent.

Wear the tray with the bleaching agent for 1 hour daily for 2 weeks . [more than this the teeth will get porous]

If the pt is using home bleaching → wait for 1 week after bleaching stops before you place any ortho brackets or composite restorations [residual peroxide will interfere with the polymerization of composite]

If teeth are mal aligned → avoid strips

OTC products - Unless a peroxide is present , the whitening effect is only stain removal

In office bleaching:

- 1- Liquidam is placed along gingival margin and light cured
- 2- Bleaching agent is placed and activated by [laser or light to increase it's temp and effectiveness]
 - ** bleaching kits have capsules of vit E , used when there is blanching of the tissues due to seepage of the bleaching gel under the barrier. Vit E is a powerful anti-oxidant ,it reverses the soft tissue damage in the gingiva – there is no actual difference in efficacy when you bleach with / without light [light is only used because the pt expects it]

Whitening should result in at least 2 shades color change

Best is doing in office bleaching then in home bleaching for 2 weeks

Q: how can you reduce relapse after bleaching?

- 1- Use power tooth brush + whitening toothpaste
- 2- Brush / rinse immediately after anything that causes stains



- 3- Drink beverages that cause stains with a straw
- 4- Annual touch up with the custom tray

Non – vital teeth bleaching :

Agents used:

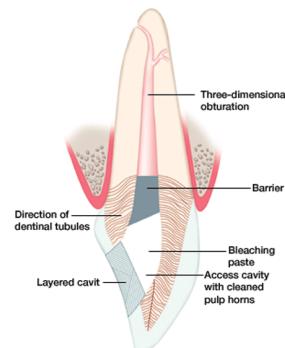
- **Superoxol** [H₂O₂ + distilled water] + **Sodium perborate** [decomposes into sodium metaborate and hydrogen peroxide and nascent oxygen]
These chemicals are mixed together to a thick paste and sealed into the access cavity
- **Thiourea**

1- Walking bleach technique:

- 1- Remove GP to a level below the CEJ
- 2- Apply barrier over GP [IRM or GIC or RMGIC]
- 3- Place the bleaching agent and seal the tooth with GIC
- 4- Remove after 1 week**
- 3- Open chamber bleaching: [internal/external bleaching]:**
 - 1- Remove GP to a level below the CEJ
 - 2- Apply barrier over GP
 - 3- Place cotton inside the cavity → pt goes home
 - 4- At home the cotton pellet is removed , the pt injects the bleaching agent inside the cavity and inside the tray
- 3- Thermo-catalytic bleaching:**

Superoxol placed in the canal + heat application

side-effect: external cervical root resorption





Lasers in endodontics

Uses of laser in endodontics :

- 1- Acute / Chronic apical periodontitis
- 2- Periapical abscess
- 3- Apical resorption
- 4- Therapy resistant long term failure cases
- 5- Combined periodontal-endodontic pathology
- 6- Partly sclerosed canals, where the apex is not reachable because of sclerosis

Commonly used lasers

Nd:YAG	Best for canal sterilization - Highest bactericidal action Laser has good penetration depth – laser can reach the apex Used to modify the morphology of the root canal and seal the root canal wall [melts the smear layer forming a homogeneous surface that seals open DT] Can be used to remove GP and broken files in cases of re treatment [less time compared to conventional methods] Better for apicoectomy – because of its coagulation effect
Diode	Less penetration depth compared to Nd:YAG Seals the DT Stimulates cells proliferation + has inhibiting effect of inflammatory enzymes
Er:YAG	Not very suitable for canal sterilization It's bactericidal effect is similar to irrigation solutions Can be used to remove ZOE sealer from canal wall

Procedure : After conventional preparation, extensive rinsing and drying of the canal with paper points → Laser fibre is inserted into the canal after marking with rubber stop [fibre does not remain at the apical stop for more than 1 sec since temp. will rise to critical levels] → Fibre is pulled from apical to coronal in circular movements to cover the whole root dentin surface –**procedure is repeated at least 5 times.**

Canal is filled with Ca hydroxide and sealed till the next appointment. [**2 sessions are needed for optimum laser supported RCT**]

In some cases, the **bacteria may actually increase after the 1 st visit ,but after the 2 nd session of irradiation**, chemical sterilization is achieved. [laser will make the bacteria more sensitive to irrigation → better eradication]

Advantages	Disadvantages
<ol style="list-style-type: none"> 1- Painless 2- Lesions treated by laser heal faster 3- Create bloodless field + reduce contamination 4- Minimizes post-operative swelling, pain and scarring 	<ol style="list-style-type: none"> 1. High cost of equipment 2. Large size 3. Need for complete knowledge of equipment, use and safety.

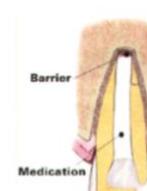
Protection against laser : Always wear protective googles, mask and use high speed suction. Avoid laser contact with water and alcohol



Regenerative endodontics

Immature teeth with open apex problems:

- 1- Difficult to clean
- 2- Very hard to get proper apical seal
- 3- Dentinal walls are very thin & weak → increased risk of cervical fracture

Immature tooth with open apex tx options	
Apexogenesis	Apexification
done if you still have some VITAL pulp tissue procedure: <ul style="list-style-type: none"> 1- Do partial pulp extirpation [leave 4-5 mm of pulp tissue apically] 2- Apply capping material [calcium hydroxide, MTA, biobentine] 3- Obturate over the capping material <p>** if you placed MTA you can obturate immediately – if you placed Calcium hydroxide you can't obturate immediately -because vital pulp tissue remains apically → the apex will develop normally and close [but the canal walls are still thin & weak]</p> 	Done if the tooth is necrotic Procedure: <ul style="list-style-type: none"> 1- Total pulp extirpation 2- Apply capping material at the apex – after a few months calcified material will form and close the apex [you check for closure of the apex by paper points not files] 3- Obturate over capping material <p>** if you placed MTA you can obturate immediately ** the apex closes but the canal walls are still thin and weak.</p> 

** both apexogenesis and apexification close the apex but the walls remain thin and weak , the only option to allow the walls to get thicker is root canal revascularization.

Root canal revascularization

*The only technique that can increase the thickness of the canal walls + close the apex + makes the tooth respond normally to sensibility testing.
Indicated for immature teeth with necrotic pulps*

First appointment:

Determine WL → irrigate with NaOCl or CHX

Second appointment: [after 3-4 weeks]

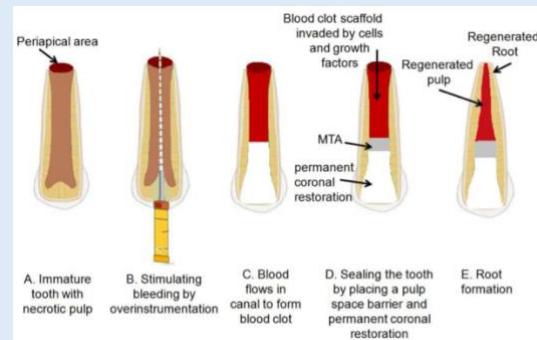
Make sure the pt is pain free, there is no exudate and the canals are dry

Insert a STERILE sharp file and go beyond the apex to induce apical bleeding until the blood reaches the CEJ – wait for 15 mins

Apply MTA then GIC

** don't irrigate with NaOCl in the second session when you want to induce bleeding.

** the apex has sth called the apical papilla which is rich in stem cells that goes into the canal when u induce bleeding – after a while pulp like tissue forms to increase canal wall thickness and close the apex + the tooth will have normal sensibility response





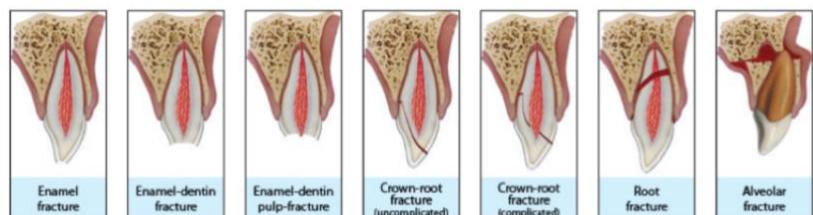
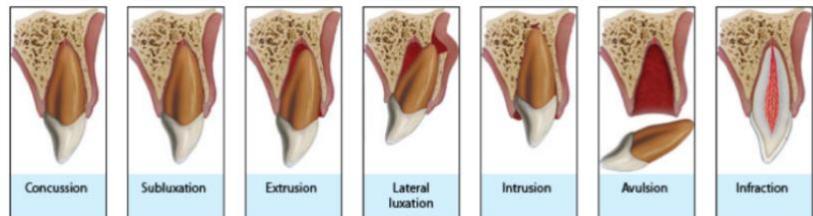


Dental trauma

General rule : not all cases of trauma need intervention some only need follow up

NOTE:

When RCT is indicated In a traumatized tooth and the tooth is still mobile → access cavity and pulp extirpation will cause more trauma to the PDL [if RCT is indicated pulp extirpation can be postponed for 10 – 14 days]



Q: why do most dentists make wrong decisions in dental trauma cases?

- 1- It is hard to determine the priority and which traumas to treat first since most cases include more than one type of trauma [ex: crown fracture + root displacement + alveolar bone fracture]
- 2- Trauma is a not sth dentists deal with on daily basis

Because teeth are hard tissues : injuries appear as fractures

Crown fractures :

- A. **Incomplete** = involves only the enamel
- B. **Un complicated** = involves the dentine
- C. **Complicated** = involves the pulp

Root fractures : are all

complicated fractures because you can't recognize fracture of the dentine if it does not involve the pulp

Crown/root fractures :

- A. **Un complicated** = involves the enamel + dentine + cementum
- B. **Complicated** = involves the enamel + dentine + cementum involves the pulp

Trauma classification

Crown fractures

Just a crack in enamel / enamel chipped off
Usually no loss of tooth structure



Incomplete fracture [crown infraction]

Uncomplicated crown fracture

Fracture confined to the enamel or might involve dentine
NO PULP EXPOSURE





Fracture involves enamel and dentine + pulp is exposed



Complicated crown fracture

Crown/ root fractures

Fracture involves enamel + dentine + cementum
No pulp exposure



Uncomplicated crown fracture

Fracture involves enamel + dentine + cementum
+ pulp exposure



Complicated crown fracture

Root fractures

Fracture involves dentine + cementum + pulp
Classified based on :

complicated fracture [ALWAYS]

- Location of the fracture [coronal / middle / apical 3rd]
- Presence of displacement of the coronal fragment [coronal / lateral displacement]



Periodontal ligament injury

The traumatic energy that reaches the root is very low
No clinical findings at root level [the only sign is the tooth is TTP]



Concussion

Might be seen with a crown fracture
No displacement or loosening of the tooth

Subluxation

The traumatic energy that reaches the root is low [but higher than concussion]
Abnormal loosening [mobility] +No displacement
TTP + Bleeding from gingival crevice



A. Intrusive:

tooth displaced into the alveolar bone
Always combined with comminution +/- fracture of alveolar socket
Clinically : the crown is **shorter** than the adjacent tooth



Luxation

If all 4 Anteriors are at the same level → means intrusion of both centrals

B. Extrusive :

Partial displacement of the tooth out of the socket in an axial direction
The tooth is usually either protruded or retruded
Clinically : the crown is **longer** than the adjacent tooth



**Alveolar socket is intact****C. Lateral:**

Displacement of the tooth in any direction other than axial

Always combined with comminution + fracture of the labial / palatal alveolar bone - [checked by palpation]

Partial or total separation of the PDL



Avulsion	Complete displacement of the tooth out of the socket
	[If the pt tells you "I couldn't find the tooth – take a PA it might be a case of complete intrusion or the pt swallowed it → take chest Xray]

**Q: why is the traumatic energy that reaches the root is very low in case of concussion?**

- The traumatic energy was low from the start causing only inflammation in the PDL and TTP
- The traumatic energy was high causing a crown fracture [which reduces the amount of energy reaching the root]

Injury to the supporting bone

Crushing + compression of the apical part of the socket

[not a real fracture]

Comminution of the alveolar socket **ALWAYS found with intrusion****Fracture of the alveolar socket wall** **ALWAYS found with lateral luxation**

Can be found with avulsion

**Fracture of the alveolar process** Fracture above the apical part of the socket [may or may not involve the socket]

Often associated with occlusal interference



Several teeth move together [Ex: when you push the central the other central + lateral will move with it]

Fracture of the jaw Fracture involves the base of the jaw
Often involves the alveolar process +/- socket treated by OMFS**Injury to the soft tissues****laceration** Deep wound or a tear resulting from a **sharp object****Contusion** Bruise [submucosal hemorrhage] resulting from a **blunt object**
No break in the mucosa**abrasion** Superficial **BLEEDING** wound resulting from rubbing or scraoing of the mucosa

- Trauma is mostly seen in children
- Most commonly seen at 2-5 YO [when they start walking] and 8- 12 [when they start playing sports]
- Trauma is more in boys than girls



- Trauma is mainly due to falling or being pushed + mostly affects maxillary centrals
- Most common trauma is uncomplicated crown fractures
- Predisposing factors [increased overjet + insufficient lip closure]

Direct trauma: the tooth itself is hit

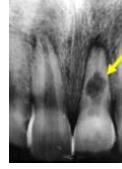
Indirect trauma : occurs during falls [the mandible closes forcefully when a person falls and hits the upper teeth] → this causes crown fractures in anterior and posterior teeth and crown / root fractures in posterior teeth + might cause jaw fractures [condyle and symphysis]

GENERAL RULES OF TRAUMA :

- | | |
|--|--|
| • High energy → crown fracture | low energy → root fracture/ luxation / alveolar fracture |
| • High mass → affects crown | low mass → affects roots |
| • High speed → affects crown | low speed → affects supporting structures |
| • Trauma with cushioned [blunt] objects → more chance of luxation or alveolar fracture or root fracture | |
| • Trauma with hard [sharp] objects → more chance of crown fractures | |
| • Trauma can have high energy and cause crown fractures → amount of energy reaching the root is low | |

Tissue response to trauma

Long term prognosis of the tooth depend greatly on the management in the emergency phase

Pulp response to trauma	
Favorable response	Unfavorable response
<p>1- Recovery</p> <p>2- Pulp fibrosis [clinically = increased pain threshold , high # on the EPT]</p> <p>3- Pulp obliteration [clinically = increased pain threshold + tooth might change color to become more yellow or white]</p> <p>Pulp canal obliteration – PCO = occurs due to deposition of 3° dentine in response to trauma</p> <p>PCO can be:</p> <p>A. Partial : pulp size is reduced on xray</p> <p>B. complete : you can't see the shadow of the canal</p> 	<p>1- infection</p> <p>2- pulp necrosis</p> <p>3- internal resorption: caused by injury to the pulp</p> <p>4- external resorption: caused by injury to the cementum + a source of infection [usually pulp necrosis]</p>  

- Completely calcified canals with PA radiolucency → RCT
- Some suggest that cases of partial PCO should be treated because they will mostly end up with complete PCO → necrosis → symptomatic apical periodontitis
- Tooth might initially look like it recovered then have partial PCO → necrosis

Q: give reasons why it is advisable not to interfere and do RCT in cases of partial PCO?



- 1- Limitations in the radio graph [there might be a space on the xray but you won't see anything after access and if you look for the canal you might end up with a perforation and extraction]
- 2- Not all cases of partial PCO will lead to symptomatic apical periodontitis

It is advisable that you only do RCT for partial PCO if the pt is symptomatic this way if you end up with a perforation and extraction the pt already had a chief complaint and they would understand .

Q: what is the management of partial PCO with symptomatic apical periodontitis? Place Ca(OH)2 apically [the high PH will neutralize the acidic medium and prevent further odontoclasts differentiation and resorption]

THE ONLY INDICATION FOR RCT AFTER TRAUMA IS EVIDENCE OF INFECTION – PUSS , SINUS TRACT ETC..

After trauma you **don't need to do RCT if there is :**

- PA radiolucency
- External root resorption
- -ve pulp test
- Discoloration of the tooth

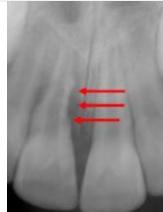
Just follow up every month

Peri radicular tissues response to trauma	
Favorable response	Unfavorable response
<ol style="list-style-type: none"> 1. Recovery 2. Fibrous healing 3. Transient apical breakdown [TAB] - injured tissues undergo a spontaneous process of repair with no permanent damage to the pulp - Misdiagnosis of this condition may result in unnecessary endodontic treatment 	<ol style="list-style-type: none"> 1. Cessation of root development 2. Disturbance in root development 3. Bone resorption 4. Gingival recession 5. External root resorption

External root resorption:

- if the source of infection was from the pulp → considered a pulpal response
- If the source of infection was from the PDL → considered a PDL response

EXTERNAL ROOT RESORPTION [TYPES]

SURFACE	Small superficial resorption in cementum and outer dentine Considered a repair process – can't be detected on xray Occurs after avulsion ** No tx needed Severely damaged cementum + exposed DT [loss of tooth surface externally] Bacteria is present inside the canal – resorption can progress rapidly and needs TX Occurs after luxation and avulsion ** Most common resorption after failed RCT	
INFLAMMATORY	Severely damaged cementum → direct contact between bone and dentine → root becomes part of the bone remodeling process [surface is replaced by bone] NO LAMINA DURA + MOTH EATEN APPERANCE OF THE ROOT	
REPLACEMENT		

**INVASIVE**

Usually occurs many years after trauma – **always cervically**
Highly vascular [bleeds on probing]

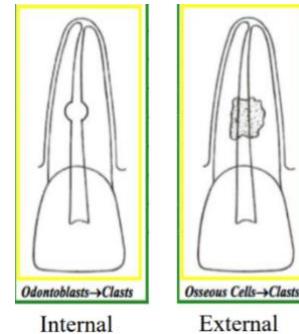
Note:

if you have doubts regarding the current RCT and the tooth will be crowned → you need to do re endo [even if the pt is asymptomatic] because the pt might have balance between the bacteria present in the canals / PA region and the immune defenses but when you place the crown the occlusal load will change and the balance is affected → resorption might start

if the RCT is good → no need for re endo

Q: how can you differentiate between external and internal root resorption? Take 2 radiographs while doing horizontal shifting and then check

Internal root resorption	External root resorption
Symmetrical	Non symmetrical
Smooth continuous borders	Rough non continuous borders
The borders of the canal will be interrupted	You can still see the borders of the canal
The lesion and the canal move together when you do shifting	The lesion and the canal move away from each other when you do shifting

**Ankylosis:**

- can occur before replacement resorption
- can occur after all other types of resorption
- can occur without resorption
- can lead to replacement resorption

Trauma to immature teeth :

High to low prognosis :

concussion → extrusion / lateral luxation → intrusion and avulsion
no pulp exposure → small exposure
→ large exposure

No signs of infection

Clinical signs of infection [puss, sinus tract, swelling , severe pain] → RCT

- Reposition the tooth to its place + stabilize it
- Protect the pulp [pulpotomy or pulp capping]
- Monitor by sensibility tests + radiographs

If enough dentine wall thickness + you can obtain apical seal → conventional RCT

Very thin dentinal walls → re vascularization

You only need to close the apex → apexification





Dental trauma management

General guidelines for trauma management:

- 1- Psychological support , history , examination and assessment → helps you **establish priorities**
- 2- **Control bleeding/ pain ** PRIORITY**
- 3- Protection [pulp , Root surface (e.g. during repositioning)]
- 4- Reposition: Teeth, bone, soft tissues
- 5- Stabilization: Bone and teeth [splint (rigid or flexible)] + Soft tissues [sutures]
- 6- **Temporary restorations [MIGHT BE A PRIORITY IF ESTHETICS IS AFFECTED]**
- 7- Medications
 - Systemic: tetanus, antibiotics, analgesics, anti-inflm.
 - Local: intra-canal dressings, chlorhexidine gel, m/w.
- 8- Follow-up

1. Psychological support , history , examination and assessment : [establish priorities]

- Smile and be confident and reassure the pt.
If the case is an emergency → control bleeding [wash the area + apply pressure or do sutures if needed] and control pain [LA or pulp extirpation or medications]
If the case is not an emergency → do full case assessment

History :

Ask when , how and where did the trauma happened?
High energy trauma but the crown did not fracture → consider root fracture

- Chief complaint [to determine priority]
- Full medical history + **tetanus immunization status**

• Examination :

- A. Mobility [tested bucco lingually], percussion, palpation [to check PDL integrity]

if there is mobility in the tooth :

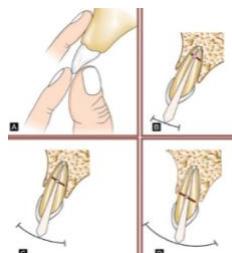
palapte and if you can feel the margin of the bone → alveolar bone fracture

if the margin is not felt → root fracture

high range of motion = cervical fracture

low range of motion = apical fracture

- B. pulp sensibility tests [to establish a baseline and not diagnosis]

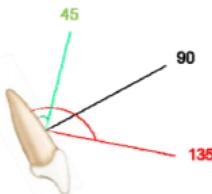


-ve pulp testing after trauma is not an indication for RCT .

Pulp tests are to establish base line record

-ve later becomes +ve → root revascularization

+ve later becomes -ve → pulp necrosis



C. radiographs:

best option is CBCT

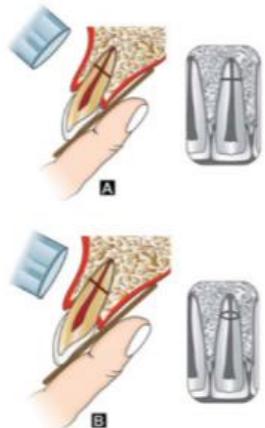
take 3 PA + 1 occlusal for affected arch + opposing arch

to check for root fracture you need to do vertical shifting [you take 3 radiograph one at 90° to the tooth and one 45° above and one 45° below]

when the xray beam is perpendicular to the tooth → fracture line appears as tilted line. When the beam is 45° above or below → fracture appears as a circle

D. Clinical photographs

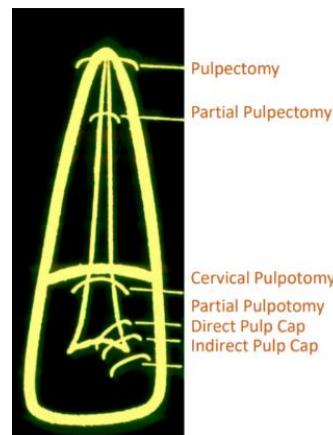
For legal purpose + monitor the treatment progress later

2. **Protection [pulp , Root surface (e.g. during repositioning)]***The aim is to preserve pulp vitality + allow further root development - Specially in immature teeth that have open apex and thin dentine walls → higher risk of cervical fracture so you want to preserve pulp vitality to continue root formation + close the apex*

Management of complicated / uncomplicated crown fractures

Management of uncomplicated crown fracture : dentine protection**Mangement of complicated crown fracture** : [pulp exposure]**Mature tooth with thick dentine walls :**If associated with **luxation injury or displacement** or In case of failure of pulp capping/ pulpotomy → RCT**Immature tooth - preserve the pulp by :**

- 1- Pulp capping
- 2- Pulpotomy [partial or cervical]
- 3- Partial pulpectomy

**Pulpotomy - removing pulp tissue from the pulp chamber only**

Partial [cvek pulpotomy]	Cervical
Only the pulp tissue underneath the exposure is removed [no access cavity is made]- The pulp chamber still has some pulp tissue left	All of the pulp tissue in the pulp chamber is removed [you need to do access cavity]
Pulpectomy – removing the pulp tissue from the canals	
Partial	complete
Leave 4-5 mm of pulp tissue apically	Completely remove all pulp tissue from canals [not an example of pulp protection – because you remove the entire pulp]

**Highest to lowest success rate in managing exposed pulp [complicated crown fracture]:**

partial pulpotomy → pulp capping → cervical pulpotomy

- Partial pulpotomy has similar success rate to RCT

Procedures for exposed pulp due to trauma [complicated crown fractures]	
Pulp capping	Partial Pulpotomy
Closed apex Less than 24 hours and minimal bacterial contamination Procedure: 1- Isolation with RD or cotton rolls + suction 2- Irrigate and achieve hemostasis using a cotton pellet of [saline, sodium hypochlorite, CHX] for 30 – 40 seconds 3- Apply capping material [calcium hydroxide , MTA, ledermix or resin modified calcium silicate (theracal)] 4- Restorative material GIC liner then composite ** GIC liner has to be placed to mask the color of the capping material before you place composite ** if the pt comes with the fractured piece after pulp capping you can place the fragment using flowable composite and then place a facial composite veneer Success of pulp capping is not related to : Age – gender – tooth location – exposure size – restoration type	For young pts [open apex] Small fractures in young pts where the pulp is large More than 24 hours with bacterial contamination Procedure: 1- Isolation 2- Using an abrasive high speed bur with coolant to remove pulp tissue from the exposure site 3- Irrigate and achieve hemostasis using a cotton pellet of [saline, sodium hypochlorite, CHX] for 30 – 40 seconds 4- Apply capping material [calcium hydroxide , MTA, ledermix or resin modified calcium silicate (theracal)] 5- Restorative material GIC liner then composite Success of partial pulpotomy is not related to : Size of the exposure size and time of seeking tx

Q: why is it better to do pulpotomy using a new diamond bur ? because it results in clean surface + bleeding stops shortly after cutting

NOTE: sometimes after pulp capping or pulpotomy there will be obliteration of the pulp tissue and calcification of the canal [due to the presence of the capping material]. **Canal calcification is higher after partial pulpotomy [because you are placing more material]**

IMP: In young patients the pulp is large and even small fractures can result in pulp exposure so if you have small fractured piece → you need to do partial pulpotomy to provide space for the pulp capping material + GIC + Composite

Q: what decides if you will go for pulp capping or pulpotomy for a complicated crown fracture?

- 1- **Age** [open apex → pulpotomy , closed apex → pulp capping]
- 2- **Type of restoration required**
- 3- **Bacterial contamination:**
 - A. **Time since exposure :** less than 24 h → pulp capping , more than 24 h → pulpotomy
After 24 hours the inflammation in the pulp extends 1.5 mm



- B. **Purgation of the wound:** trauma in a dirty environment or by a dirty object and bacterial contamination is present → do pulpotomy to remove contaminated layers, aseptic exposure → pulp capping
- C. **Exposure area :** the larger the exposure size the higher the chance of bacterial contamination
Deep extension : if the trauma was caused by a sharp object that penetrated deep into the pulp → pulpotomy

Pulp capping / pulpotomy materials:

1- Calcium hydroxide

- Most commonly used agent [gold standard]
- High PH that causes a superficial layer of necrosis and underneath layer of calcified tissue [the necrotic layer is a requirement for the formation of the calcified layer]
- **Broad spectrum antimicrobial**

2- Ledermix cement

- Corticosteroid : Triamcinolone + Antibiotic : Demeclocycline + Calcium hydroxide + Zinc oxide-eugenol
- the main content of ledermix = ZOE
- **Very strong anti inflammatory agent [most is released in the first day but full effect is reached after 3 days]**
- Has the potential to **inhibit inflammatory root resorption specially after luxation injuries**
When can you place it :
 - A. Vital pulp tissue remaining inside the canal
 - B. You did pulp extirpation but you won't see the pt for a long time
 - C. the pt is in pain and LA is not effective → place ledermix and then re access after 3-5 days

3- MTA

- Ferrous oxide causes the grey color of MTA / Bismuth oxide causes the discoloration of MTA when it is applied
- Hydrophilic [can work in moisture areas]
- Excellent sealing ability [bacteria tight seal] + produced a hard tissue bridge faster and with less defects compared to CaOH₂

NOTES IMP:

- If you place non setting Ca OH₂ over vital pulp tissue → pt will feel pain
- If you did pulp extirpation and you won't see the pt for a long time [multiple weeks] → DON'T PUT CaOH₂ because it will cause calcifications in the canal
- Ledermix paste = intracanal medication ledermix cement = pulp capping agent
- dentine bridge can be detected : radiographically , clinically [by microscope] , histologically
- MTA is superior to CaOH₂ in pulp capping and pulpotomies but CaOH₂ is superior in apexifications

Protection of the root surface [only in cases of avulsion] – the aim is to maintain PDL vitality to allow re implantation + proper healing and prevent root resorption and ankylosis



Management of crown / root fractures

To know if complicated or not → remove fragment + take radiograph or CBCT

Uncomplicated crown root fracture [without pulp involvement]:

- 1- Remove the mobile fragment and clean the area
- 2- Suture gingival lacerations if presents
- 3- GIC on exposed dentine above gingival level [if you can't replace GIC immediately u can do it maximum after 24 hours]
- 4- Expose the margin of the fracture (gingivectomy/crown lengthening/ orthodontic extrusion)
- 5- Permanent restoration
If no time, or until a definitive treatment plan is made → A temporary stabilization of the loose segment to adjacent teeth is done

Complicated crown / root fracture [with pulp involvement] :

A. Non restorable tooth → extraction

B. Restorable tooth :

Complete apex	Open apex
<ul style="list-style-type: none">• Remove the mobile fragment and clean the area• Suture gingival lacerations if presents• Do RCT then Orthodontic extrusion of apical fragment or Crown lengthening• Composite/ post & core/ crown	<ul style="list-style-type: none">• Remove the mobile fragment if does not affect restorability OR Stabilize the loose segment to adjacent teeth temporary (Temporary management)• Do Pulp capping or pulpotomy then Orthodontic extrusion of apical fragment or Crown lengthening• Composite/ post & core/ crown

** for all crown root fracture cases F/U clinically and radiographically after 6-8 week and after 1 year

Management of root fractures

Management of root fractures : [protection of the pulp tissue and the PDL is not applied in root fractures]

- 1- Reposition the tooth with digital finger pressure (if needed)
- 2- Suture the lacerations (if present)
- 3- Apply **flexible splint for 4 weeks** (if mobility)
F/ U after **6-8 weeks, 6 months, 1 and 5 years**

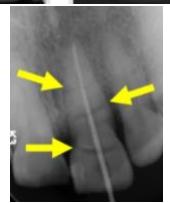
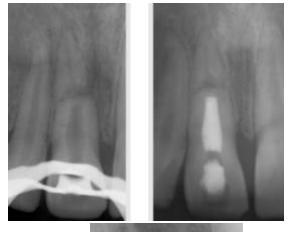
Q: Do all cases of root fracture need RCT? No, RCT is indicated if:

- A. There are clinical symptoms of irreversible pulpitis
- B. During follow up you see evidence of pulp necrosis [sinus tract , swelling , puss]
- C. You are doing internal splinting



Q: If RCT is done where should it stop? Depends on the case:

- If you are doing RCT because of pulpal necrosis or irreversible pulpitis → you only do RCT to the **coronal fragment** [even if you can reach the apical fragment] - treat only to the fracture line and place long term CaOH₂ for hard tissue repair.
- If you are doing RCT because you want to do internal splinting → RCT should reach the the apical fragment.



Internal splinting : indicated if you have **multiple root fractures** , you stabilize then using fiber post that connects all parts together .

Q: what is the rationale behind doing RCT only to the coronal fragment in case of root fracture?

The trauma got reduced greatly at the fracture line which means that the apical part has enough blood supply + intact nerve fibers and will stay vital [if failure occurs it will occur at the fracture line not apical fragment]

Management of concussion / subluxation

Concussion:

- TTP from concussion might not occur immediately , it might be delayed for a few days
 - RCT can cause TTP sometimes but it disappears after 3 days
- Concussion does not require any treatment – but if severe discomfort you can reduce the tooth from occlusion a little bit**
- Follow up: up to 1 year**

Subluxation :

- Usually no need for treatment
 - A flexible splint for patient comfort up to 2-4 weeks + Soft food for 1 week and OHI
- Follow up: up to 1 year**

Management of extrusion / lateral luxation

Extrusion	Lateral luxation
Both have:	
Percussion sensibility: negative	
Sensibility test: negative	
Radiography: enlargement of apical periodontal space	
Excessive mobility + exposure of root surface	High metallic sound + no mobility [because it is contacting bone]



Management:

- 1- Rinse the exposed part of the root surface with saline before repositioning
 - 2- Apply a local anesthesia (specially for lateral luxation)
 - 3- Reposition the tooth with your fingers
 - 4- Flexible splint for 2 weeks (extrusion) and 4 weeks (lateral luxation – because it is mostly associated with bone fracture)
- Follow up: up to 5 years**
- Initially in lateral luxation / extrusion we don't do RCT unless there is necrotic pulp.**



NOTE: Most cases of **extrusion** will end up with pulp necrosis so it is advisable to do RCT shortly after splinting to prevent inflammatory resorption

Management of intrusion

Intrusion	Intrusion is not
<p>Percussion: has high metallic sound No mobility Sensibility test: usually negative Radiography: no periodontal space Tooth looks shorter than adjacent teeth</p> <p>considered an emergency [no need to start definitive treatment right away]</p>	 <p>Both intrusion and lateral luxation have high metallic sound on percussion and no mobility</p>

Immediate treatment for intrusion:

Soft food for 1 week + Brushing with a soft brush and rinsing with chlorhexidine 0.1 %

F/U: 2,4, 6-8 weeks, 6 months, 1 year and yearly for 5 years

Definitive treatment for intrusion: depends on **stage of root development** and **intrusion level**

To know how much the root got intruded you can take a CBCT or compare it to the level of the adjacent tooth

TX options :

- 1- Spontaneous repositioning
- 2- Orthodontic repositioning
- 3- Surgical repositioning

Apex	Level of intrusion	Management
Open apex	Up to 7 mm	Spontaneous repositioning
	More than 7 mm	Orthodontic OR surgical repositioning [both will give same results – decision depends on what the pt wants the tx]
Closed apex	Up to 3 mm	Spontaneous repositioning
	3-7 mm	Orthodontic OR surgical repositioning
	More than 7 mm	Only surgical repositioning

** if you see the pt immediately after trauma and both surgery + ortho are indicated → do surgery , if you see the pt after the bone and soft tissue healed → do ortho [to avoid further tissue trauma]

RCT :

- Complete root formation [closed apex] → do RCT [preferably be initiated within 3-4 weeks post-trauma or 2-3 weeks post surgery]
After cleaning and shaping you cannot obturate immediately you need to place long sessions CaOH₂ dressing
- Incomplete root formation [open apex] → only do RCT if there is evidence of pulp necrosis



Q: why do you need to place long sessions of CaOH₂ after intrusion injuries? The high PH of CaOH₂ will prevent the development of osteoclasts/ dentinoclasts and it will remove the source of infection and prevent inflammatory resorption

Q: what are the complications of intrusive luxation?

Complications are more in mature teeth

- 1- Necrosis
- 2- Replacement resorption
- 3- Inflammatory resorption
- 4- Marginal bone loss [from the trauma itself]

Q: why is inflammatory resorption a complication of intrusion? The trauma causes injury to the cementum and PDL + if the necrotic pulp is not removed in the correct timing → inflammatory resorption

Management of avulsion

Best management for avulsion is to reimplant the tooth immediately after avulsion [you can rinse it for a few seconds under running water and then reimplant – but washing should not exceed 10 seconds]

First aid that can be done by anyone around the pt [before they can come to you]:

- 1- Calm the pt down
- 2- Hold the tooth from the crown and wash it briefly under running water for a maximum of 10 seconds
- 3- Ask the pt to bite on a handkerchief to hold the tooth in position
- 4- Seek emergency dental treatment

OR

Hold the tooth from the crown → place in suitable storage medium and seek emergency dental treatment

Best to worst storage mediums [culture media → milk → saliva (kept inside the mouth in the cheek) → saline]

Teeth should never be placed in water [it will cause lysis of the PDL cells]

By preventing the root surface from drying you decrease the chance of **replacement resorption**

By doing RCT + giving systemic ABX you are removing the source of infection and reducing the chance of **inflammatory resorption**

**ALL CASES OF AVULSION REQUIRE
ABX FOR MATURE AND IMMATURE
APEX**

Storage media for avulsed teeth:

MEDIUM	CHARACTERISTICS
WATER	DO NOT USE Causes rapid cell lysis- does not have the correct osmolarity Only a quick rinse if nothing else is available
SALINE	Tooth can be kept for max 1 hour Does not contain nutrients for the cells
SALIVA	Tooth can be kept for max 2 hour Contains a lot of bacteria → risk of infection
MILK	Tooth can be kept for max 6 hours Has suitable PH and osmolarity DO NOT USE YOGURT OR SOUR MILK → PH IS TOO LOW AND NOT SUITABLE



TISSUE CULTURE
MEDIUM
HANK'S
BALANCED SALT
SOLUTION [
HBBS]

BEST TO USE – rarely available [because the solution has to be kept at 4 °
Tooth can be kept for 4 days
Can be kept at room temp

Save a tooth : half filled with HBBS and contains either a basket or chambers to limit the tooth mobility and reduce the chance of damage to the cells



In clinic: 2 scenarios

Tooth has been replanted

- 1- Clean the area
- 2- Verify normal position of the replanted tooth
- 3- Suture gingival lacerations if present
- 4- Apply a flexible splint for up to 2 weeks
- 5- Administer systemic antibiotics
 - Tetracycline (Doxycycline 2mg/ kg of body weight 2x per day for 7 days)
OR
 - Phenoxyethyl Penicillin or amoxicillin
Refer to physician for a tetanus booster

CAUTION : IF THE PT IS BELOW 8 DO NOT GIVE TETRACYCLINE AND GIVE PENICILLIN INSTEAD

PT instructions:

Avoid participation in contact sports

Soft food for up to 2 weeks

Brush teeth with a soft toothbrush after each meal

Use a chlorhexidine (0.1 %) mouth rinse twice a day for 1 week

F/U = Clinical and radiographic control after 2, 4 weeks, 3, 6 months, 1 year and then yearly thereafter

Tooth is still outside the socket

- A. Extraoral dry time is less than 60 mins [PDL cells are still viable]

Soak the tooth in saline to remove contamination and dead cells

IF INCOMPLETE APEX : Topical application of **antibiotics (minocycline or doxycycline 1 mg per 20 ml saline for 5 minutes soak)**

IF COMPLETE APEX: RCT is indicated, **can be initiated in 7-10 days**

Then

local anesthesia, examine the socket [clean and irrigate the socket + remove blood clot]

Replant the tooth gently + Apply a **flexible splint for up to 2 weeks**

Administer systemic antibiotics

- Tetracycline (Doxycycline 2x per day for 7 days)
OR
- Phenoxyethyl Penicillin (Pen V) or amoxicillin
Refer to physician for a tetanus booster

- B. Extra oral dry time more than 60 mins [no PDL cells]



Remove attached non-viable soft tissue carefully

Root canal treatment can be performed (closed apex)

Treat the root surface with 2 % sodium fluoride solution for 20 min [to decrease the chance of replacement resorption]

local anesthesia, examine the socket [clean and irrigate the socket + remove blood clot]

Replant the tooth gently + Apply a **flexible splint for up to 4 weeks**

Administer systemic antibiotics

- Tetracycline (Doxycycline 2x per day for 7 days)
OR
- Phenoxyethyl Penicillin (Pen V) or amoxicillin
Refer to physician for a tetanus booster

PT instructions:

Avoid participation in contact sports

Soft food for up to 2 weeks

Brush teeth with a soft toothbrush after each meal

Use a chlorhexidine (0.1 %) mouth rinse twice a day for 1 week

F/U = Clinical and radiographic control after 2, 4 weeks, 3, 6 months, 1 year and then yearly thereafter

RCT indications in avulsion :

- 1- Tooth replanted before arrival to clinic and tooth has closed apex → do RCT after 7- 10 days
- 2- Tooth [with closed apex] was extraorally **less than 60 mins** → do RCT after 7-10 days
- 3- Tooth with [open or closed apex] was extraorally **for more than 60 mins** → you can do RCT immediately or after 7- 10 days

RCT in trauma is indicated in :

Complicated crown fractures or Crown / root fractures

And 2-3 week after intrusion repositioning

ABX are only indicated in cases of avulsion

repositioning and stabilizing always come together

Repositioning tooth or bone: Anesthesia - Use **gentle finger forces** - Always **check occlusion** - Take x-ray – apply suitable splint

Stabilizing:

- A. **Soft tissues :** by sutures [for optimum healing + maintain tissue position and prevent gingival recession]
Q: what happens if you don't suture? Poor healing + Gingival recession and bone loss
- B. **Bone and teeth :** by splints



Splinting

Flexible [functional, semi rigid, non rigid splint]	Rigid splint
<p>Most commonly used splints Extends to include one tooth on each side Reduces the risk of ankylosis Allows functional healing of the PDL EX: composite + ortho wire [composite splint] Titanium trauma splint Used in: Splinting teeth with dislocation injuries or root fractures in the middle / apical 3rd</p> 	<p>Two adjacent teeth from each side are included [if you increase the # of teeth included on each side of the splint you will increase the rigidity of the splint even if you use the same material] EX: titanium ring splint Bracket splint , schuchardt splint Used in: alveolar process fractures or root fractures in the cervical part</p> 

Splint requirements:

- 1- can be created quickly outside the lab using conventional dental materials + inexpensive
 - 2- easy to apply - easy to remove without damaging dental hard tissue
 - 3- should not traumatize teeth or surrounding tissues
 - 4- should not interfere with occlusion, dental hygiene, or endodontic treatment.
 - 5- should help restore the original tooth position
 - 6- ensure adequate fixation over the entire immobilization period
 - 7- should achieve rigidity or flexibility
- intrusion / extrusion / lateral luxation → semi rigid splint for 2 weeks
 - alveolar bone fracture → rigid splint for 4 weeks
 - cervical root fracture → 4 months

Temporary restorations in trauma cases:

1- fragment restoration:

if the broken fragment was kept in a dry environment [gauze / tissue] it has less chance for success + it will have a different color than the rest of the tooth

to prevent the color change:

- A. keep the fragment in suitable solution
- B. do a labial composite veneer over the fragment



2- fiber post and crown :

if the entire crown is lost → you do partial pulpectomy + place a temp fiber post inside the canal and etch and coronal part of the post and build it up with composite then cement the post using ZOE



3- If you don't have enough time:

cover the tooth with Vaseline and then inject FUJI 9 GIC slightly inside the canal and let it overflow and remove it and seat it several times then cement it



Medications in trauma cases :

Q: when should you give ABX in trauma ? medically compromised pt and all cases of avulsion

In avulsion:

SYSTEMIC :

- Tetanus toxoid → Check status (10 years) – specially if the wound is contaminated with dirt
- Antibiotics : Penicillin / amoxycillin OR Tetracyclines [best]
- NSAID's : Ibuprofen - Synergism with tetracyclines
- Use NSAID's for analgesic + anti-inflammatory actions

LOCAL :

- Intracanal dressing of ledermix paste
- CHX gel apply with cotton bud or finger 2-3 times daily for 2-3 weeks
- CHX mouthwash : after each meal and until 2 days after suture removal

Follow up : In every follow up you :

- 1- Examine soft tissues
- 2- Examine teeth [percussion / palpation / mobility/ color changes]
- 3- Pulp testing [cold test + EPT]
- 4- PA radiographs + clinical photographs
 - Suture removal after 5- 6 days
 - Flexible splint removed after 2 weeks, rigid splint after 4 week

NOTE: if RCT is indicated after trauma it can still be delayed for 10- 14 days



Management of root resorption

- 1- **Internal resorption** : asymptomatic and is a chance radiographic appearance only painful if there is perforation
- Pink tooth in case of cervical resorption
 - RCT IS INDICATED OTHERWISE TOOTH NEEDS EXO



Without perforation

RCT [irrigation with US activation + place CaOH₂ for a while then obturate using warm GP technique]

With perforation

Depending on the perforation location and extent:

- If you can seal the perforation from inside the canal → CaOH₂ or MTA
- Surgical repair
- Extraction

External resorptions:

1- Surface resorption:

- Rarely seen on radio graph – **No tx needed [it is part of the normal healing response]**

2- Inflammatory resorption : [trauma to PDL / cementum + infection]

- **The only type that can be controlled**
 - Seen in **luxation, intrusion or avulsion**
 - May arrest with RCT
 - Prevented by **the systemic ABX and pulp removal [removing the source of infection]**
- 3- Replacement resorption :**
- Associated with **reimplantation**
 - Transient → no tx just follow up
 - Progressive [associated with PDL removal] → extraction
If replacement resorption is **only apically** → push CaOH₂ out of the apex [it's high pH will arrest the resorption]



invasive cervical resorption - ICR

Causes of ICR:

The actual cause is unknown but there are predisposing factors

- 1- Ortho treatment and orthognathic surgery ** [most common cause]
 - 2- Trauma / bruxism
 - 3- GTR + tetracycline conditioning of the root
 - 4- Reimplantation of avulsed teeth **
 - 5- Intracoronal Bleaching [specially if it was done by hydrogen peroxide and heat activation]
 - 6- Restorations near or at the cervical margin
- ** mostly it is trauma + other factors that cause ICR

Clinical Features:

- 1- Located cervically
- 2- **Resorbed cavity is replaced by high vascular tissue** → severe bleeding on probing in that area
- 3- **No pain** [because the pulp remains protected by an intact layer of dentin and predentine until late in the process]
- 4- **In late stages**, ectopic calcifications deposited directly onto the resorbed dentine surface
- 5- may be evident as a pink coronal discoloration



Pink coronal discoloration is found in both internal resorption and ICR

In the late stages of invasive cervical resorption → pain + ectopic calcifications

Radiographical features:

- Varies from a well delineated to an irregularly "moth-eaten" radiolucency which can be confused as root caries
- A characteristic radio-opaque white line between the lesion and the pulp [represents the predentine and dentine]
- **To differentiate between root caries and ICR you need to depend on the clinical features of ICR [bleeding on probing and pink discolouration]**



In case there is a gap between cementum and enamel → most susceptible to ICR

Resorption occurs in 2 phases:

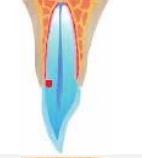
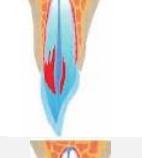
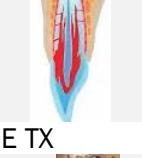
- 1- ICR originates in the **cervical area below the epithelial attachment** → proceeds from a small cervical opening to involve a large part of **dentin between the cementum and the pulp**
- 2- It progresses and reaches the **predentin**, then spreads laterally in an apical and coronal direction enveloping the root canal (**Predentin is more resistant to resorption**)





CLASSIFICATION OF INVASIVE CERVICAL RESORPTION

BASED ON SPREAD INTO DENTINE

CLASS I	A small lesion with shallow penetration into dentine	
CLASS II	lesion that has penetrated close to the coronal pulp chamber but shows little or no extension into the radicular dentin	
CLASS III	Lesion involving the coronal dentine + extending at least to the coronal third of the root	
CLASS IV	Lesions extends beyond the coronal third of the root canal and may involve almost the entire root	
FRANK'S CLASSIFICATION [RELATION WITH THE CRESTAL BONE] – USED TO DETERMINE TX		
INTRA OSSEOUS	not accompanied by periodontal breakdown	
CRESTAL	At the level of the alveolar bone	
SUPRA-OSSEOUS	coronal to the level of the alveolar bone	

Treatment: stop the resorptive process and restore the lost tooth structure – if the cervical resorption is not cleaned properly and some tissue is left → lesion will continue to cause resorption

Management of ICR

An external approach FOR SUPRA OSSEOUS ICR and CRESTAL ICR	Crestal ICR	Internal approach FOR INTRAOSEOUS ICR
flap reflection → curettage and restoration with amalgam or composite resin or GIC or MTA ** in case of pulp exposure during external approach → RCT DISADV= gingival recession [prevented by GTR membranes (Gortex)]	Traditionally, tooth was treated by RCT followed by repair of the resorative area by internal approach or external approach Recently, external approach is preferable = if there is exposure / symptoms → RCT MTA is suggested in this case	RCT followed by internal repair

** MTA can be used for both internal and external approaches



In treating ICR we always try to avoid doing an RCT [maintain pulp vitality] unless there is an indication.

RCT is NOT needed in class I and class II and if the pulp is vital and testing within normal limits

RCT indications in ICR cases:

- 1- Pulp exposure
- 2- Non vital tooth [necrotic pulp]
- 3- Class III or IV resorption [because any attempt to debride the area will result in pulp exposure or irreversible pulpitis]
- 4- Resorption extending to more than one surface
- 5- Tooth is symptomatic

Clinical management of ICR cases [class I and class II] :

To know if the resorption has spread to other areas → take CBCT before you access

- 1- Apply glycerol to protect soft tissues
- 2- curette the soft tissue from the defect **using excavator** [avoid using hand piece because it can easily remove the thin pre dentine layer causing pulp exposure]
- 3- Topical application of **90% aqueous solution of TCA “Trichloro acetic acid” in a cotton pellet (> 1 min)** – **the cotton pellet with TCA should be pushed against gauze to remove excess material**

TCA will ensure that the dentinoclasts are removed from the defect BUT it causes **coagulation necrosis of soft tissue - results in a surface that does not bond well**

CAUTION: avoid touching the gingiva with TCA → it can cause chemical burns

- 4- Restore the defect with GIC

GIC is :

well tolerated by the periodontium when placed subgingivally

provides immediate seal (unlike MTA) – MTA has long setting time and by the time it sets some of it would get out of the Cavity

esthetically acceptable + can easily be veneered with composite when necessary

if you access and then see that the lesion has spread to other surfaces → do RCT and combine internal and external approach together

class IV → extraction

Q: why is the prognosis od ICR is uncertain ? because you cannot determine if you removed all the inflammatory tissues from the lesion

The most important thing in ICR treatment is removing all of the inflammatory tissues



Summary of trauma management

Trauma	Management	Follow up
Concussion	No treatment needed but if the pt has discomfort you can reduce the tooth from occlusion a little bit	Up to one year
Subluxation	No treatment is usually needed for pt comfort place a flexible split for 2- 4 weeks + instruct the pt to have soft diet for 1 week	
Extrusive / lateral Luxation	<p>1- Rinse the exposed part of the root surface with saline before repositioning</p> <p>2- Apply a local anesthesia (specially for lateral luxation)</p> <p>3- Reposition the tooth with your fingers</p> <p>4- Flexible splint for 2 weeks (extrusion) and 4 weeks (lateral luxation – because it is mostly associated with bone fracture)</p> <p>Initially in lateral luxation / extrusion we don't do RCT unless there is necrotic pulp.</p> <p>Most cases of extrusive luxation will end up with necrosis → do RCT shortly after splinting</p>	up to 5 years
Intrusion	<p>Immediate tx : soft diet for one week + Brushing with a soft brush and rinsing with chlorhexidine 0.1 %</p> <p>Definitive tx : Depends on the level of intrusion and the apex.</p> <p>Open apex [less than 7 mm intrusion] → spontaneous repositioning</p> <p>Open apex [more than 7 mm intrusion] → ortho or surgical repositioning</p> <p>Closed apex [up to 3 mm intrusion] → spontaneous repositioning</p> <p>Closed apex [3-7 mm intrusion] → ortho or surgical</p> <p>Closed apex [more than 7 mm intrusion] → surgical repositioning</p> <p>RCT is indicated in all closed apex , and only indicated in open apex if there is evidence of necrosis [place long session of CaOH2]</p>	2,4, 6-8 weeks, 6 months, 1 year and yearly for 5 years

Crown fractures		
Trauma	Management	Follow up
Crown infraction	TX needed to minimise chances of bacterial ingress to the pulp that is possibly damaged or inflamed from trauma + to prevent the discolouration of the infraction lines. Etching and sealing with resin to prevent discolouration of the infraction lines - Apply as soon as possible after trauma to minimise bacterial penetration	No follow up needed - Unless they are associated with other types of trauma
Uncomplicated crown fracture	Dentine protection with liners then composite restoration	Clinical and radiographic control at 6-8 weeks 1 year
Complicated crown fracture	Pulp capping / pulpotomy RCT - in older patients with completely formed teeth especially if associated with luxation injury or displacement or In case of failure of pulp capping/ pulpotomy	
Uncomplicated crown root fracture	Remove segment → clean area + suture lacerations then place GIC on exposed dentine and exposure the fracture margin with [gingivectomy/crown lengthening/ orthodontic extrusion] → final restoration	
Complicated crown root fracture	Unrestorable tooth → extraction Restorable tooth: Mature apex : Remove segment → clean area + suture lacerations then do RCT followed by crown lengthening or ortho extrusion and final restoration [composite post / core / crown]	



	Immature apex: Remove segment → clean area + suture lacerations then do pulp capping / pulpotomy followed by crown lengthening or ortho extrusion and final restoration [composite post / core / crown]	
Root fracture	Reposition the tooth with digital finger pressure (if needed) Suture the lacerations (if present) Apply flexible splint for 4 weeks (if mobility)	after 6-8 weeks, 6 months, 1 and 5 years
Avulsion	<p>Tooth has been replanted before arriving to clinic:</p> <ol style="list-style-type: none"> 1- Clean the area + verify normal position of the replanted tooth 2- Suture gingival lacerations if present 3- Apply a flexible splint for up to 2 weeks 4- Administer systemic antibiotics <p>Extraoral dry time is less than 60 mins [PDL cells are still viable]:</p> <ol style="list-style-type: none"> 1. Soak the tooth in saline to remove contamination and dead cells <p>IF INCOMPLETE APEX : Topical application of antibiotics (minocycline or doxycycline 1 mg per 20 ml saline for 5 minutes soak)</p> <p>IF COMPLETE APEX: RCT is indicated, can be initiated in 7-10 days</p> <ol style="list-style-type: none"> 2. local anesthesia, examine the socket [clean and irrigate the socket + remove blood clot] 3. Replant the tooth gently + Apply a flexible splint for up to 2 weeks <p>Extra oral dry time more than 60 mins [no PDL cells]</p> <p>Remove attached non-viable soft tissue carefully Root canal treatment can be performed (closed apex)</p> <p>Treat the root surface with 2 % sodium fluoride solution for 20 min [to decrease the chance of replacement resorption]</p> <p>local anesthesia, examine the socket [clean and irrigate the socket + remove blood clot] Replant the tooth gently + Apply a flexible splint for up to 4 weeks</p> <p>For all cases u prescribe ABX:</p> <ul style="list-style-type: none"> • Tetracycline (Doxycycline 2mg/ kg of body weight 2x per day for 7 days) OR • Phenoxyethyl Penicillin or amoxicillin Refer to physician for a tetanus booster <p>CAUTION : IF THE PT IS BELOW 8 DO NOT GIVE TETRACYCLINE AND GIVE PENICILLIN INSTEAD</p> <p>PT instructions:</p> <p>Avoid participation in contact sports Soft food for up to 2 weeks Brush teeth with a soft toothbrush after each meal Use a chlorhexidine (0.1 %) mouth rinse twice a day for 1 week</p>	



Endodontic surgery

Endodontic Surgery should be the choice only when non-surgical treatment has failed or the problem cannot be treated non-surgically

ENDODONTIC SURGICAL TECHNIQUES :

A. SURGICAL FISTULATION

1. Incision and drainage
2. Cortical trephination

B. PERIRADICULAR SURGERY

1. Periradicular curettage
2. Root-end resection (apicoectomy)
3. Root-end preparation (retroprep)and root end filling (retrofilling)

C. CORRECTIVE SURGERY

1. Perforation repair
 - a. Resorptive and carious
 - b. Mechanical
2. Periodontal management
 - a. Root amputation
 - b. Hemisection
 - c. Regenerative techniques
 - d. Exploration to confirm suspected vertical root fracture
3. Intentional replantation (Extraction-Replantation)
4. Surgical repositioning of luxated teeth
5. Surgical uncovering and orthodontic extrusion of endodontically treated teeth
6. Decompression of large periradicular lesions





Indications for Periapical Surgery :

- Biopsy of the periapical lesion is required
- Foreign body reaction with extruded material
- Perforation repair (that can not be done conservatively)
- If non-surgical treatment is not feasible - such as:
 - Very long or wide post; Post not in line with canal
 - Canal blocked by broken file, calcifications, etc
 - Tooth is not likely to be suitable for further restoration
- Patient factors (Medical / dental condition, time, costs, recent crown, etc.)

CONTRAINDICATIONS FOR SURGICAL ENDODONTICS

A. PATIENT'S MEDICAL STATUS

1. Uncontrolled hypertension
2. Recent myocardial infarction
3. Uncontrolled diabetes
4. Dialysis patients
5. Uncontrolled bleeding disorders
6. Immuno-compromised patients

B. Patient's mental / psychological health:

1. Patient does not desire surgery
2. Patient unable to handle stress of long complicated procedure
3. Patient extremely apprehensive

C. Non restorable tooth

D. Poor periodontal prognosis

E. Inadequate access to surgical area

1. Thick buccal cortical plate/external oblique ridge
2. Limited opening
3. Shallow palatal vault
4. Shallow vestibule

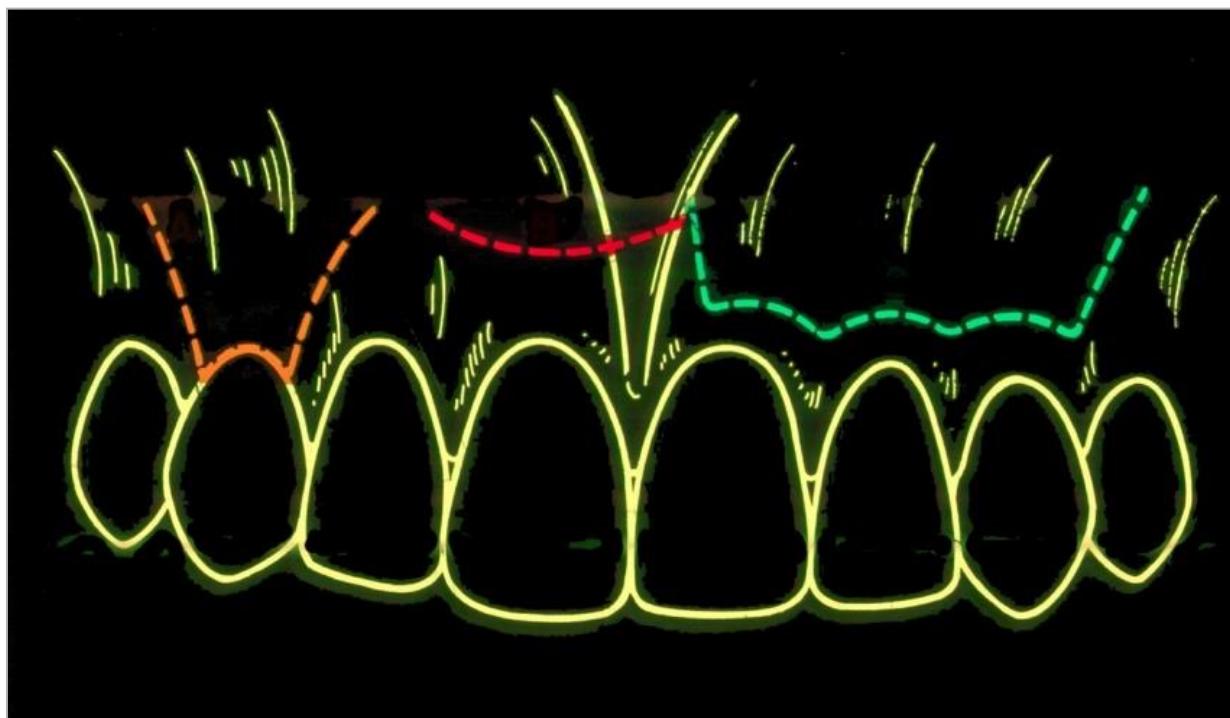


Endodontic Surgery steps:

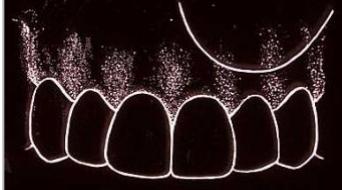
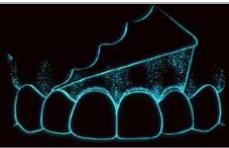
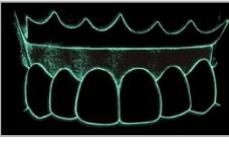
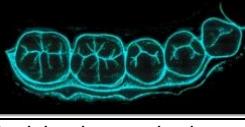
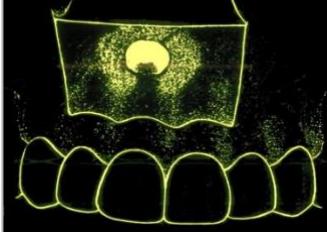
1. Local Anaesthesia
2. Consultation, Diagnosis, Treatment Plan
3. Periosteal Flap
4. Curettage
5. Apicoectomy
6. Retrograde Endodontic Treatment (Apical Bevel, Canal Preparation, Root Filling)
7. Wound Closure - sutures
8. Post-operative Instructions
9. Follow-up & Review

Flap designs

- Semi-Lunar
- Gingival crest (Intrasulcular)
 - 1- a)Triangular b)Trapezoidal
 - 2- Gingival
- Luebke-Oschenbein



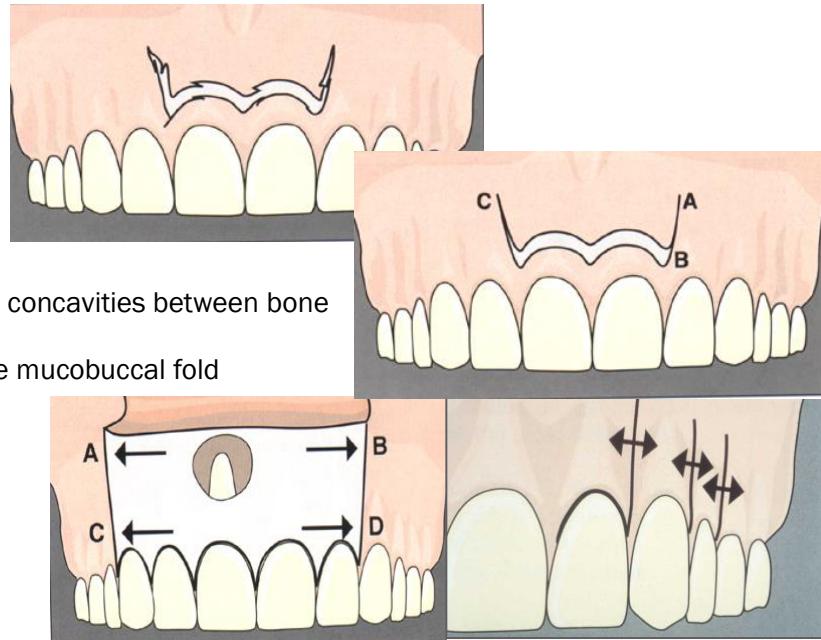


Flap Designs	Advantages	Disadvantages
Semi-Lunar In the mucobuccal fold and attached gingiva 		<ul style="list-style-type: none"> Poor access Incision often over the lesion Difficult moisture control (haemorrhage) Difficult to reposition Uncomfortable during healing Leaves scars
Gingival crest (Intrasulcular) 	<ul style="list-style-type: none"> Horizontal incision not crossing bone defect. Greater access for lateral root repair Useful in short roots and coronal third defects Easy reposition Maximal blood supply 	<ul style="list-style-type: none"> Difficult flap elevation Irreversible pocket formation if used in presence of dehiscence Long vertical and horizontal incisions required Changes in the level of the marginal gingiva Difficult suturing Difficult to maintain oral hygiene during healing period
Triangular 		<p>✓ "First choice" flap for endodontic surgery</p> <ul style="list-style-type: none"> Good access Good vision Good moisture control Heals without scars Easy to reposition
Trapezoidal 	Begin as a triangular flap and then do 2 nd vertical incision if extra access required	<p>✓ "Second choice" for endodontic surgery</p> <ul style="list-style-type: none"> Good access & vision Good moisture control Heals without scars Easy to reposition
Gingival 	Extended horizontal incision No vertical incision	<ul style="list-style-type: none"> No access to apex May be useful for coronal third perforations Used for palatal flaps <i>But difficult!</i>
Luebke-Oschenbein Scalloped horizontal incision in attached gingiva <ul style="list-style-type: none"> 3 - 5 mm short of the gingival margin Follows contours of the gingival margin Vertical incisions <ul style="list-style-type: none"> 1 or 2 mm short of entering the mucobuccal Fold (Depends on how much access is required) 	<ul style="list-style-type: none"> Simple Good access No gingival recession, because the marginal gingiva is not disturbed. (Use for anterior teeth with crowns) Easily repositioned flap The patient is able to maintain good oral hygiene during the healing period 	<ul style="list-style-type: none"> An unaesthetic scar may form Muscular attachments & frenums may need modification of the horizontal incision Misjudging the size of lesion may result in the incision crossing the osseous defect



General Principles for Periosteal Flaps

- 1- The incision for a full mucoperiosteal flap (mucosa, connective tissue, periosteum) must be made with a firm continuous stroke.
- 2- An incision should not cross an existing underlying bony defect.
- 3- The vertical incision (s) should be made in the concavities between bone eminences.
- 4- The vertical incision should not extend into the mucobuccal fold
- 5- The termination of the vertical incision at the gingival crest must be at the mesial or distal line angle of the tooth.
- 6- The base of the flap must be at least equal to the width of its free end.



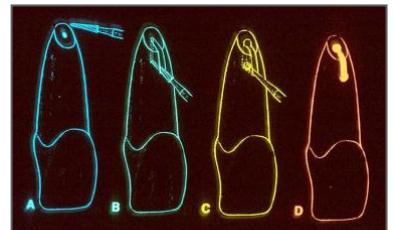
Apical Bevel

Done by:

1-Round bur or 2-noncutting-tip fissure bur

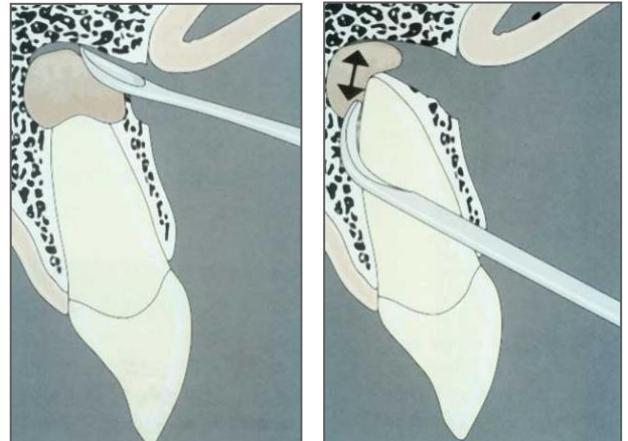
Amount of root removed depend on: 1-Degree needed to examine root exits, zips, perforation

2-Wide surface to prepare Class I cavity



Curettage Techniques :

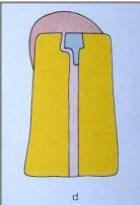
To remove all pathologic tissue, foreign bodies, and root and bone particles from the periradicular area.





Retrograde filling materials

Amalgam - Cavit - IRM - Super-EBA - Composite resins - Gutta percha - Glass ionomers - MTA

Retrograde Filling Materials	Disadvantages & Problems	
Amalgam	<ul style="list-style-type: none"> ▶ Corrosion ▶ Galvanism (with posts) ▶ Tattoo on mucosa ▶ Expansion ▶ Dimensional changes ▶ Marginal breakdown ▶ Excess not absorbable ▶ Mercury release 	<ul style="list-style-type: none"> ▶ Difficult to condense ▶ Condensation scatter ▶ Cavity large ▶ Undercuts needed ▶ Poor adaptation to walls ▶ No anti-bacterial action ▶ Difficult to remove for re-treatment
		
IRM + Super-EBA	<ul style="list-style-type: none"> ▶ Poor tissue compatibility <ul style="list-style-type: none"> ◦ Due to continuous release of eugenol ◦ Fibrosis of adjacent tissue ▶ Soluble ▶ Large cavity required ▶ Difficult to handle material <ul style="list-style-type: none"> ◦ Esp. Super-EBA 	
	Advantages	Disadvantages
Glass Ionomer	<ul style="list-style-type: none"> ▶ Low tissue toxicity <ul style="list-style-type: none"> ◦ Bone apposition ▶ Good sealing ability ▶ Chemical bond to dentine ▶ Radiopaque ▶ Easy to mix & place ▶ Colour contrast to tooth ▶ Short setting time 	<ul style="list-style-type: none"> ▶ Moisture control <ul style="list-style-type: none"> ◦ Haemorrhage ▶ Relatively large cavity required
Gutta Percha + Sealer	<ul style="list-style-type: none"> ▶ Low tissue toxicity ▶ Good sealing ability ▶ Radiopaque ▶ Colour contrast to tooth ▶ Conservative cavity only ▶ Anti-bacterial (sealer) 	<ul style="list-style-type: none"> ▶ Easy to mix & place ▶ Good physical properties ▶ Satisfies requirements of root filling materials ▶ Proven and acceptable material for RCF's for over 120 years
MTA (Mineral trioxide aggregate)	<ul style="list-style-type: none"> ▶ Superior seal compared with Super EBA ▶ Low toxicity ▶ Healing of the p.a. tissues with cementum forming over the material ▶ Need moisture to set 	<ul style="list-style-type: none"> ▶ Relatively large cavity required ▶ No resistance to dense compaction ▶ Washing out the material during flush the bony crypt ▶ Setting time 2-4 hours

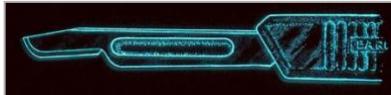


Endodontic Surgery Kit :

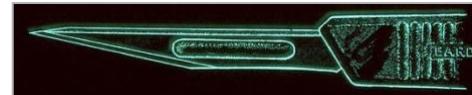
- ▶ Explorer + mirror + Twizer
- ▶ Scalpel
- ▶ Periosteal elevator
- ▶ Curette
- ▶ Tissue Retractors
- ▶ Tissue & suture scissors
- ▶ Needle holder
- ▶ Tissue forceps



No. 15 - for periosteal flaps

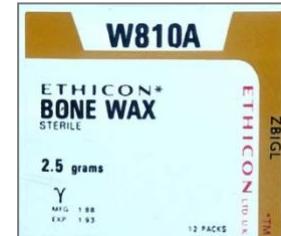


No. 11 - for incision and drainage (Stabbing action)



Hemorrhage Control

- 1-Adrenaline → with pressure
- 2-Bone wax (Mechanical)
- 3-Ferric sulfate
- 4-Microcrysatalline collagen substances



After placement of root end filling, an interim radiograph should be exposed to ensure that:

- 1-Root tip has been totally removed.
- 2-No excess material is present in the ossous crypt.
- 3-Placement of root end filling is adequate.

Suturing(with absorbable or non absorbable suture)

After suturing: The flap should be compressed with digital pressure and a moist gauze for 5 – 10 mins. To decrease the size of coagulum and enhances healing.

Post-Operative Instructions

1. Ice pack(10 mins. on & 10 mins. off)
2. Rest for a day
3. Analgesics & NSAIDs drugs (ibuprofen)
4. Antibiotics (only) in case of signs and symptoms of systemic infection, or patient medical status
5. Rinsing of surgical site with warm salt water 3-4 times a day, beginning the day after surgery.





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